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ED-WINGED BLACKBIRD: A STUDY IN E ECOLOGY OF A CAT-TAIL MARSH

By ARTHUR A. ALLEN

Presented to the Faculty of the College of Arts and Sciences for the
Degree of Doctor of Philosophy

[From Abstract of Proceedings, Linnaean Society of New York,
Nos. 24-25, 1911-13]

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PLATE I.

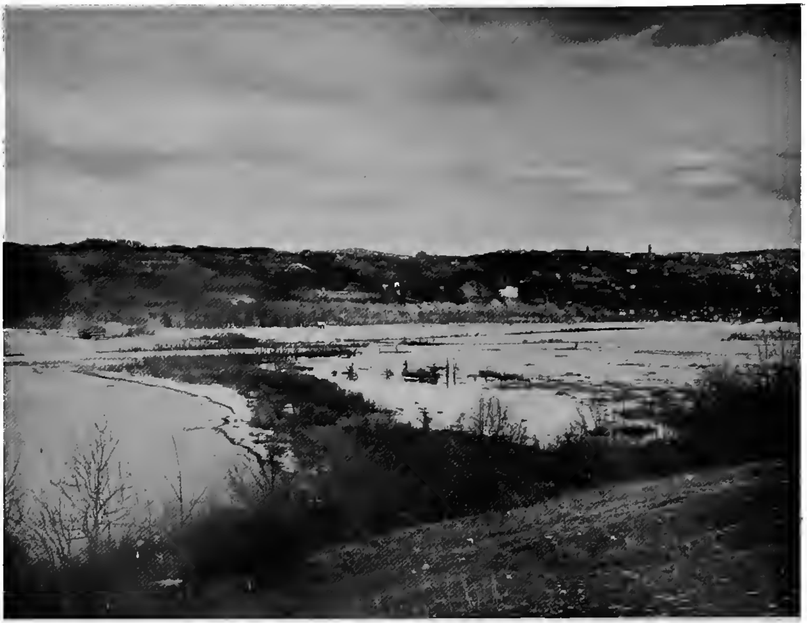

FIG. 1.—RENWICK MARSH AND THE HEAD OF CAYUGA LAKE FROM WEST HILL DURING THE MARCH FLOODS.

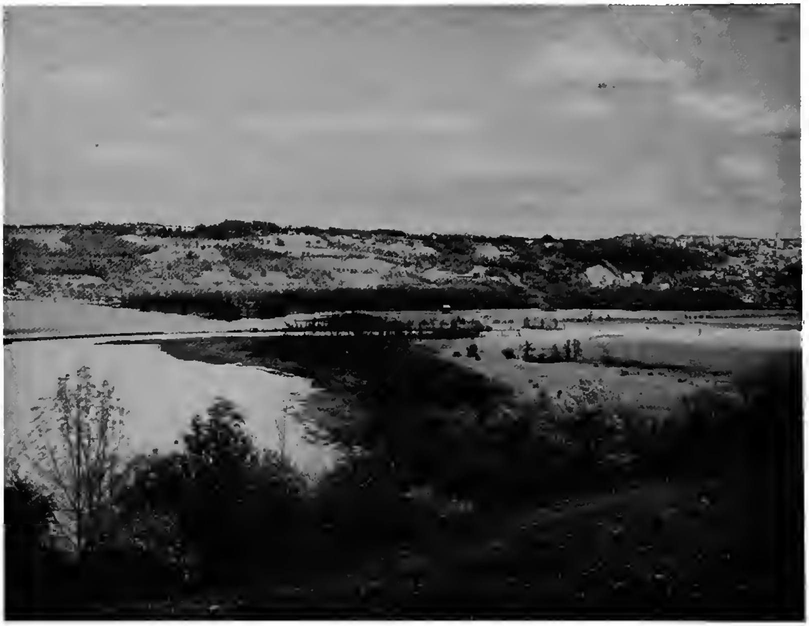

FIG. 2.—THE SAME DURING THE MIDDLE OF MAY.

[Reprinted from ABSTRACT OF THE PROCEEDINGS OF THE LINNAEAN SOCIETY OF NEW YORK, Nos., 24–25, April 15, 1914.]

THE RED-WINGED BLACKBIRD: A STUDY IN THE ECOLOGY OF A CAT-TAIL MARSH.

BY ARTHUR A. ALLEN,
Zoölogical Laboratory, Cornell University.*

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INTRODUCTION.

Of the many problems in the scientific study of birds, none is more suggestive than that of local distribution. One walks through the open fields in the month of June, and finds there a concourse of birds that he knows will be found nowhere else. There are the Savannah, Vesper, and Grasshopper Sparrows, Bobolinks, and Meadowlarks, birds which are said to be typical of such an environment. Passing on to the overgrown borders of a wooded area, he finds Song Sparrows, Yellow Warblers, Redstarts, Red-eyed Vireos, and Catbirds—a different assemblage. Thus, in passing from one distinct type of environment to another, ~~t~~he passes from one distinct group of birds to another. The botanists have long recognized the importance of similar associations or societies of plants, and have done much toward determining their controlling factors. Environments have been intensively studied, and their meteorological and physiographic conditions determined. The various factors imposed by organic and chemical agencies have been investigated, and the resulting adaptations of species and individuals have been correlated. The whole has placed the botanist on terms of intimacy with the natural life processes of the object which he studies—a state not yet attained by the zoologist. For the student of animal ecology there remains an almost virgin field. Especially is this true in the study of birds. Here much preliminary work has been done in the way of collecting data concerning distribution, migration, and variation. Outlines of the life histories of most of the birds have been formulated. In a few instances environments have been described with appended lists of bird inhabitants. This is valuable and necessary, but far from final. What has been done toward the correlation of these various factors? From almost any volume on birds one can very easily tabulate all of the known differences in structure between the Vesper, Song, and Swamp Sparrows. He can find described at some length the habitat or environment in which each is found. But where can he find set forth the factors which determine that one bird shall inhabit the open fields, another the undergrowth, and a third the marshes? What is the exact nature of the environment in which each lives, and wherein are these environments dissimilar? What are the adaptations of each species to its peculiar habitat, and how has each become dependent upon it? Questions such as these demand an intimate knowledge, not only of every phase of the life history of each bird, but also of every condition that might be imposed by its surroundings. The nearer completeness can be approached in this knowledge, the more nearly perfect will be the understanding of the relations existing and the reasons for these relations. Investigations in this subject must of necessity become intensive rather than extensive. The known facts are yet too meager to admit of broad generalities or the comprehension of such diverse relations as exist in even a normally circumscribed habitat. For this reason, one environment has been selected for study, and efforts have been concentrated upon a single species.

The cat-tail marsh, which is here considered, is as peculiar and distinctive as any environment available for study. Great expanses of sedge, rush, and cat-tail conceal an assemblage of birds which are as interesting as they are little known—birds that are little known because of the difficulties in their study, that are seldom seen because of their secretive habits, yet withal, birds that are as unique in their adaptations, as varied in their structure and habits, as any other similar group. There are the Rails, the Coot, and the Gallinule constituting an ecological unit in themselves, the Marsh Wren, Swamp Sparrow, and Red-winged Blackbird another, the Least and American Bitterns, and the Pied-billed Grebe still others. All are strictly marsh birds which seem to find their optimum environment in the cat-tail marsh. With some of these birds, adaptation to a marsh life is very evident, but with others, it is quite obscure. The long legs of the Virginia Rail for wading, the long toes for grasping the floating debris and distributing the weight, the long bill for probing, the color, the compressed shape—like that of a flea—for slipping through the dense vegetation, are decided specializations for a life in this peculiar environment. The Swamp Sparrow and the Redwing, on the other hand, show no striking modifications, and their adaptations to this habitat are, at best, obscure. By an intensive study of these birds and the factors of the environment in which they live, it is hoped to gain some definite knowledge of the processes which are ever present, moulding their actions, shaping structure to habit and habit to structure—processes which have exterminated whole races of birds in the past and which even to-day are creating new ones.

PART I. THE ENVIRONMENT.

In beginning investigations of this kind, the first requisite is an intimate knowledge of the environment to be considered—a knowledge which cannot be gained by a few months of casual observation, but which requires years of intensive study. The discussion which follows is but a brief outline of the facts that ought to be known.

Geographically, the tract under consideration, known as Renwick Marsh,* is situated in the central part of New York State at the head of Cayuga Lake. Its latitude is 42° 27′ north, its longitude, 76° 29′ west. The marsh proper covers approximately 450 acres and is almost at lake level, its altitude being 383 feet. Concerning the ancient history of Cayuga Lake or the "Finger Lakes" in general, little need be said here. They represent preglacial river valleys, widened and deepened by the action of the ice, and left in most places with rather precipitous shores. As a result, the marsh is sheltered on the east and on the west by hills which rise about 400 feet in the first half mile, and reach an altitude of 1,400 or 1,500 feet within five miles. Physiographically, the marsh represents a delta formed by the streams that flow into the lake at its southern end—Cayuga Inlet, Fall Creek, and Cascadilla Creek. The marsh probably originated from the stagnation of the waters behind a bar that was formed across the head of the lake by the action of northerly winds and the lateral tributaries,

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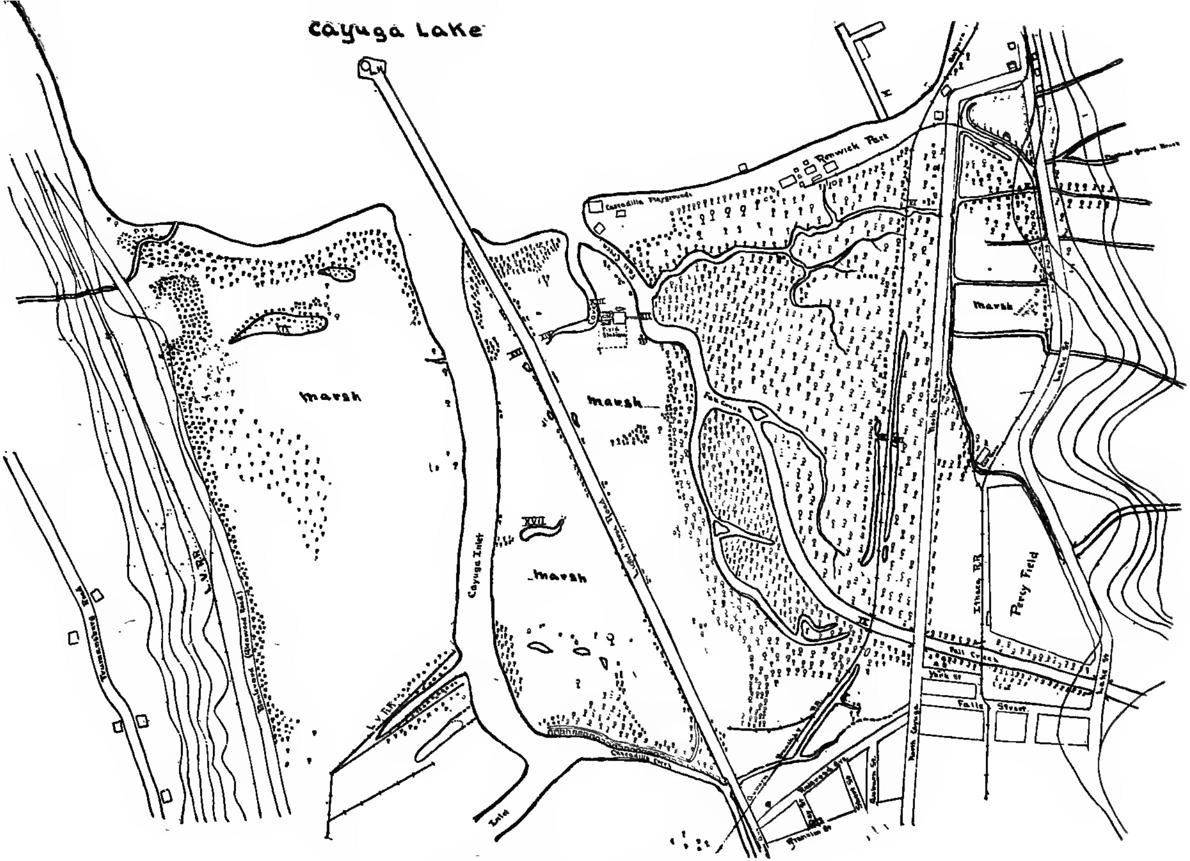
* Since the completion of this study, dredging operations for the Barge Canal, resulting in the deepening and widening of the Inlet, and the consequent filling on each side, have almost completely destroyed the marsh and replaced it with extensive, dry, sandy flats of little ornithological interest.



MAP OF RENWICK MARSH AND THE HEAD OF CAYUGA LAKE.

Williams and Pleasant Grove Brooks (Plate II). At present this bar rises a few feet above the lake on one side and the marsh on the other, and is covered with a growth of willows (*Salix nigra*) and alders (*Alnus incana*). The marsh continues southward up the Inlet Valley for a distance of two miles, as a series of more or less interrupted flood plains. Omitting from consideration the southerly two-thirds of this stretch, which has been greatly modified by human agencies, we shall confine our observations to that area north of the junction of Cascadilla Creek and the Inlet, about seven-tenths of a mile from the lake. From this point the Inlet continues almost due north through what is here recognized as the marsh proper. In former years each of these streams undoubtedly pursued a much more meandering course, as is evidenced by various long, narrow ponds and lagoons still in existence. The straightening and dredging of the Inlet for navigation have doubtless modified the marsh to a great extent. The change is most evident at present in that part west of the Inlet. Into this portion flow several small tributaries from the hill on the west. Before the banks of the Inlet were thrown up at the time of dredging, these tributaries probably had well-worn channels by which they made their way to the Inlet. The banks formed by the dredge then dammed the channels, and forced the water to spread over the marsh before finding an outlet. Consequently a grove of elm and ash, which had established itself over a large portion of the western border, became too greatly inundated and was gradually drowned. All that remain of these woods to-day are a few dead trees still standing, and numerous fallen trunks. It has been largely replaced by a growth of cat-tail, a reversion of the process which is taking place elsewhere in the marsh, where the trees are crowding upon the cat-tails.

Fall Creek, entering from the east, north of Cascadilla Creek, flows in a northwesterly direction to the lake. Its delta has been built up considerably higher than the rest of the marsh, and is now covered with a growth of large elms, maples, and sycamores. Discussion of the various meanders of this stream and of the radical changes in its course, which have taken place even in recent years, will be omitted. All of the lagoons and coves which transect the woods (Plate II) are former channels of this stream. By the building of a road (North Cayuga Street) and the consequent damming of lateral tributaries from the hill toward the east, processes like those described for the western part of the marsh have been at work, resulting similarly in dead trees and patches of open marsh.

The marsh, according to Miller's criterion (1899), evidently belongs to the Transition Zone, with a stronger admixture of the southern than of the northern elements. Of the 22 birds listed by him as finding the northern limit of their breeding range in the Transition Zone, 15 have been found breeding in or about the marsh:

Colinus virginianus		Bob-white
Bonasa umbellus umbellus		Ruffed Grouse
Zenaidura macroura carolinensis		Mourning Dove
Coccyzus americanus		Yellow-billed Cuckoo
Empidonax minimus		Least Flycatcher
Icterus galbula		Baltimore Oriole
Pipilo erythropthalmus	on the adjacent dry hills	Towhee
Ammodramus savannarum australis		Grasshopper Sparrow
Passerina cyanea		Indigo Bunting
Stelgidopteryx serripennis		Rough-winged Swallow
Dendroica æstiva		Yellow Warbler
Telmatodytes palustris		Long-billed Marsh Wren
Dumetella carolinensis		Catbird
Hylocichla mustelina		Wood Thrush
Sialia sialis		Bluebird

Of the 12 northern birds finding the southern limit of their breeding range in the Transition Zone, but four have been found nesting in the marsh:

Podilymbus podiceps	Pied-billed Grebe
Empidonax trailii alnorum	Alder Flycatcher
Penthestes atricapillus	Chickadee
Hylocichla fuscescens	Veery

Of the plants listed, too many are from the uplands to admit of a significant comparison.

Of the mammals given, five of the eight of Transitional occurrence are found here:

Sylvilagus floridanus mearnsi Allen	Cottontail
Sciuropterus volans volans (Linn.)	Southern Flying Squirrel
Sciurus hudsonicus loquax Bangs	Southeastern Red Squirrel
Peromyscus leucopus noveboracensis (Fischer)	Deer Mouse
Eptesicus fuscus fuscus (Beauvois)	Brown Bat

Two of the three having northern tendencies have been found:

Tamias striatus lysteri (Richardson)	Northeastern Chipmunk
Mustela cicognanii cicognanii (Bonaparte)	Small Brown Weasel

The Austral Zone is represented by only one mammal, *Pipistrellus subflavus*, and by one bird, *Icteria virens*, which is found in the near vicinity. Of the Canadian mammals and birds, none are known to breed within this area.

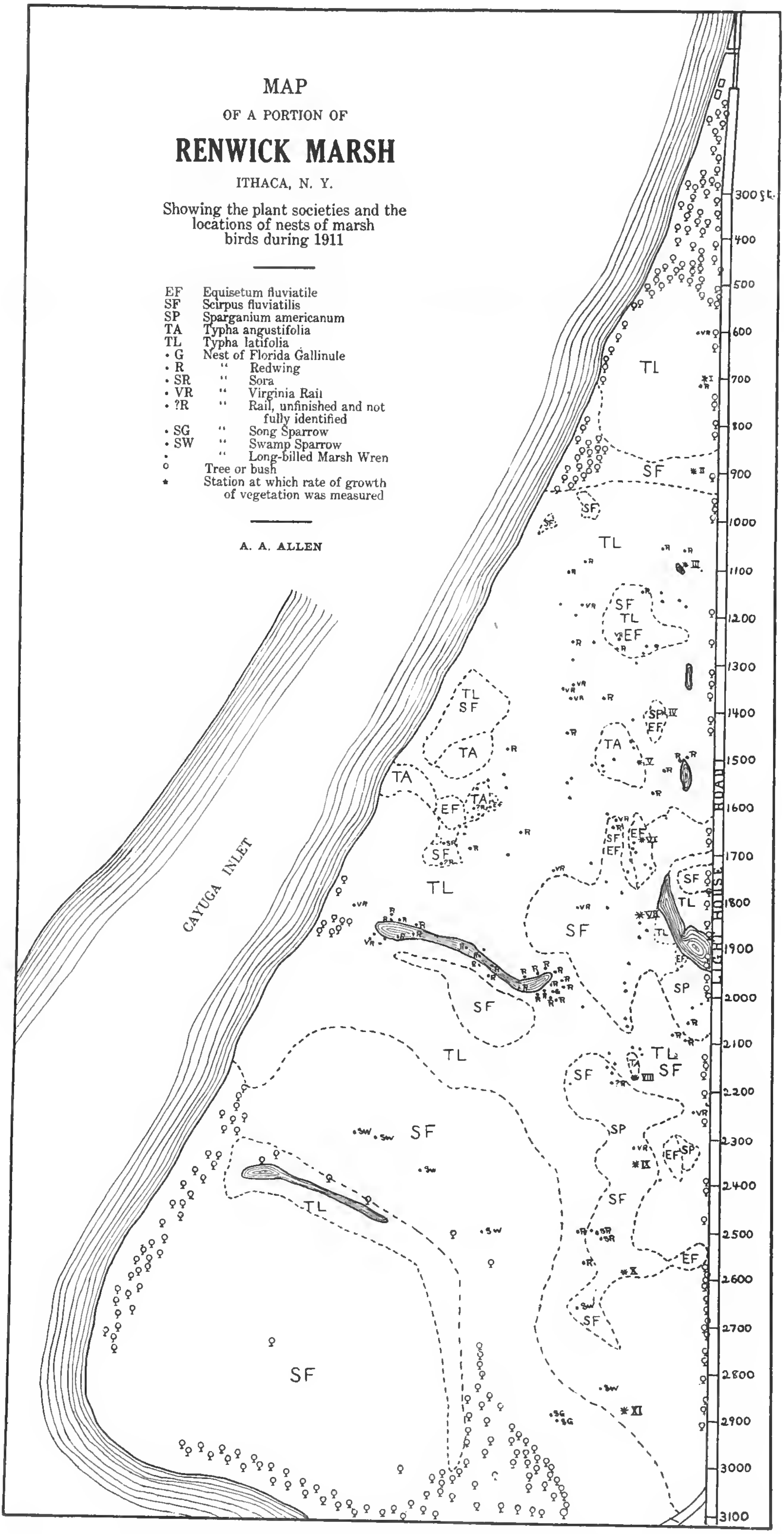
In this connection it was deemed advisable to determine the exact temperature conditions of the marsh. Accordingly, a proper shelter was provided, and a recording thermograph and hygrograph were installed. The "kiosk" was constructed in such a way as to admit of the free passage of air and at the same time to afford protection from the wind and the direct rays of the sun. Each week, when the clocks of the instruments were wound, the records were checked by means of a maximum-minimum thermometer and a whirling hygrometer. By applying Merriam's (1909) laws of temperature control, the sum of the mean daily temperatures above 43° F., from June, 1909, to June, 1910, was found to be 13,350. The normal mean temperature of the six hottest consecutive weeks was 69.5° F. The corresponding temperatures for the Transition Zone, as given by Merriam, are 10,000 and 71.6° F., respectively. In order to compare the temperature of the marsh with that of the uplands, curves of the temperatures recorded at the U. S. Weather Bureau Station at Ithaca were plotted on the same sheet with those for the marsh. (The Weather Bureau is located on the roof of one of the agricultural buildings of Cornell University, 546 feet above the marsh.) Aside from occasional fluctuations which were extremely erratic with regard to season, it was found that the two curves followed one another very closely. There was not the great difference between the spring temperatures of the hill and of the valley, which was supposed to account for the early appearance of amphibians in the marsh; nor was the coolness of the autumn, presumed by Dudley (1886) to account for the late flowering of the fall asters along the lake shore, recorded to any extent in the marsh. The sequence of differences was as follows:

	Mean Temperature.		Difference.
	Marsh.	Weather Bureau.	
January	23.75	25.3	−1.55
February	21.5	23.2	−1.7
March	41.0	42.0	−1.0
April	49.06	49.8	−0.74
May	53.1	54.2	−1.1
June	64.8	64.6	+0.2
July	67.8	68.7	−0.1
August	66.0	67.3	−1.3
September	60.26	60.2	+ .06
October	46.2	46.7	− .5
November	44.15	44.0	+ .75
December	25.8	26.1	−0.3
Average for year	47.0	47.69	−0.69

Inasmuch as the differences were so slight, inquiry into their cause and nature will not be here considered in detail. It will be sufficient to know that, in general, the average temperature of the marsh is *not* higher than that of the upland.

In order to become familiar with all of the physical features of the marsh before beginning the ecological study, and because of the lack of a good map, it was deemed advisable to chart the region lying between the two sheltering hills and

PLATE III.



Map of a portion of Renwick Marsh showing plant societies and distribution of birds' nests.

extending from Cascadilla Creek to the lake. This tract is a mile wide and about four-fifths of a mile long, and covers, as stated above, about 450 acres. Accordingly, in the winter of 1908, such a map was roughly prepared (Plate II). Upon it were located the woods, the watercourses, and the natural landmarks that might be useful. For an intensive study, it was decided to have a more detailed map of a portion of the marsh, and in the spring of 1910 a tract was selected which seemed representative, and was at the same time available from the Biological Field Station.* This tract (Plate III), which is delineated by the Inlet, Cascadilla Creek, and a road extending through the marsh to the lighthouse, is roughly triangular in outline. It is 3,750 feet in length and 1,250 feet in greatest width, and covers about 62 acres. With chain and planetable it was accurately outlined, and the trees, bushes, and other landmarks were indicated. The ponds and plant societies were added by means of the planetable and a series of flags, which was erected every hundred feet along the lighthouse road.

In this area each nest, as soon as discovered, was tagged and marked upon the chart. Records were kept of the depth of the water at the nest, the height of the nest above the water, its structure, and the nature of the vegetation in which it was built. Entries were made as to its progress at each observation. In this way, in 1910, 163 different nests were located and visited from time to time. Of these, 74 were built by Marsh Wrens, 51 by Red-winged Blackbirds, 10 by Virginia Rails, 2 by Sora Rails, 10 others by Rails, but not finished and therefore not fully identified, 8 by Swamp Sparrows, 3 by Song Sparrows, and 1 by a Florida Gallinule. Many of these nests, especially those of the Redwing and the Marsh Wren, were never completed, and of those completed, many were destroyed before the eggs hatched, and still others before the young could leave the nest. A general summary showed that of the 51 Redwings' nest carefully observed, 12 were deserted before completion, in 14 the eggs were destroyed, by natural agencies or otherwise, before hatching, and in 3 the young were destroyed before leaving the nest. Seven of the remainder were watched to maturity.

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* The Biological Field Station of Cornell University, located in the marsh near the mouth of Fall Creek; Professor J. G. Needham, Director.

In addition, more or less complete notes were kept on many nests in other parts of the marsh. Besides the observations made in charting these nests, almost daily observations for two seasons were recorded on the migrating birds, especially as they came into the marsh in the evening and left in the morning. Days were spent in studying their actions through binocular field glasses, and for hours at a time individual nests were watched and photographed from a blind at arm's length.

A discussion of the environment from the standpoint of the plant societies will be considered first. Other phases, including seasonal changes, will be taken up in connection with corresponding stages in the life history of the bird. Although the zonal arrangement of these societies is best observed about the large ponds in the marshes at the north end of Cayuga Lake, it may be traced quite easily along the Cove and in places along the head of the lake.

1. The Open-water Association.

This association, which extends throughout the open and deeper waters of the marsh, is characterized by a number of species of algæ and potamogetons which cover the bottom even in the deepest parts. In the shallower portions such plants as *Elodea*, *Myriophyllum*, and *Utricularia* predominate. The more important plants included in this environment are the following:

Castalia odorata (Ait.) Woodville & Wood	Sweet-scented Water-lily
Ceratophyllum demersum L.	Hornwort
Elodea canadensis Michx.	Water-weed
Heteranthera dubia (Jacq.) MacM.	Mud Plantain
Lemna minor L.	Duckweed
Lemna trisulca L.	Duckweed
Marsilea quadrifolia L.	European Marsilea
Myriophyllum spicatum L.	Water Milfoil

Najas flexilis (Willd.) Rostk. & Schmidt	Slender Naiad
Nymphaea advena (Ait.)	Spatter-dock
Potamogeton amplifolius Tuckerm.	Large-leaved Pondweed
Potamogeton crispus L.	Curled-leaved Pondweed
Potamogeton natans L.	Common Floating Pondweed
Potamogeton pectinatus L.	Fennel-leaved Pondweed
Potamogeton perfoliatus L.	Clasping-leaved Pondweed
Potamogeton Robbinsii Oakes.	Robbins' Pondweed
Utricularia vulgaris americana Gray	Greater Bladderwort
Ranunculus aquatalis capillaceus DC.	White Water-crowfoot
Vallisneria spiralis L.	Eel-grass

In the ecology of bird life, the plants of this zone gain importance by supplying forage for certain of the Ducks (the Wood Duck is the only one that breeds here), the Coot, the Florida Gallinule, and the Pied-billed Grebe. This forage consists of the stems, leaves, and rootlets of the plants, the fruiting parts not yet having been found in the food of any of the birds. Indirectly they supply food by harboring the larvæ of many insects which, when adults, are eaten in considerable quantities. The presence of fishes, which are the food of the Kingfisher and (to some extent) of the Grebe, is likewise determined by the vegetation and the invertebrate life which it shelters.

There are no mammals which can be considered strictly typical of this habitat. Although the Muskrat forages along the bottom for molluscs, it is more typical of the next association.

The bats which seek their food over the surface of the creeks and the Cove, belong more properly to the woods. Their food, however, is largely the midges and other Diptera, the larvæ of which develop in the open-water association. The following have been taken in the marsh:

Lasiurus borealis (Müller)	Red Bat
Lasionycteris noctivagans (Le Conte)	Silvery Bat
Pipistrella subflavus subflavus (F. Cuvier)	Georgia Bat
Eptesicus fuscus fuscus (Beauvois)	Brown Bat
Myotis lucifugus (Le Conte)	Little Brown Bat

The fishes, although probably having little direct influence in the lives of any of the birds save the Kingfisher, Grebe, and Herons, may well be listed. Many species enter the marsh to spawn, and at certain seasons the pools fairly teem with their young. If Fall Creek and the Inlet were to be considered as part of the marsh, this list would include practically the entire fish fauna of the Cayuga basin.* It will be restricted, therefore, to those forms which have been found spawning in the marsh, or which occur in sufficient numbers to indicate that they probably spawn here.

Amiatus calva (Linn.). Bowfin. It is reported that this fish has been seen to capture and swallow the young of marsh birds. It spawns during May. The young, accompanied by the male, have been taken early in June.

Ameiurus nebulosus (Le Sueur). Common Bullhead. It spawns abundantly in shallow water along the shores of the Cove and along the head of the lake, beginning about the first of June. It enters the marsh early in April, becoming very abundant during the first part of May.

Schilbeodes gyrinus (Mitchill). Tadpole Cat. Not at all uncommon; it probably spawns along the shores, where numerous young are taken in September.

Catostomus commersonii (Lacépède). Common Sucker. One of the most common fishes in the creeks; it spawns more or less in the marsh, where large schools of young appear about the middle of May.

Pimephales notatus (Rafinesque). Blunt-nosed Minnow. Quite abundant in the Cove at times, especially about the middle of April. It spawns along the head of the lake through June and July.

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* For a complete list see "The Vertebrates of the Cayuga Lake Basin, N. Y.," by Hugh D. Reed and Albert H. Wright, *Proceedings Am. Philos. Soc.*, Vol. XLVIII, No. 193, 1909.

Semotilus atromaculatus (Mitchill). Horned Dace. Not uncommon, but not a characteristic fish.

Abramis crysoleucas (Mitchill). Golden Shiner. One of the most abundant fishes of the Cove. It begins to run early in April, but does not begin to spawn until the latter part of May. It provides the chief forage for the larger predaceous fishes and for the Kingfisher. It occurs in large schools.

Hybognathus nuchalis Agassiz. Silvery Minnow. Discovered in the Cayuga basin for the first time in 1910, and then in considerable numbers. Schools containing ripe males and females were taken during the latter part of April and the first of May.

Notropis cayuga Meek. Cayuga Minnow.

Notropis heterodon (Cope). Varying-toothed Minnow. Both this and the preceding species are fairly common in the Cove.

Notropis hudsonius (DeWitt Clinton). Spot-tailed Minnow. This species enters the marsh during the latter part of April and the first of May.

Notropis whipplii (Girard). Silverfin.

Notropis cornutus (Mitchill). Redfin. This and the preceding species frequently occur, but they are not characteristic marsh forms.

Cyprinus carpio (Linn.). Carp. Extremely common at certain seasons. It comes up into the Cove early in May, but does not spawn until after the first of June. At this time the water plants are found covered with its eggs. As many as 2,800 eggs were counted by Mr. J. T. Lloyd on one square yard of the aquatic vegetation.

Anguilla chrysypa (Rafinesque). Common Eel. It is not uncommon in the creeks, and probably occurs in the marsh, although it has never been taken there.

Pomolobus pseudoharengus (Wilson.) Alewife. Frequently taken in the Cove during May and June, when it comes from the deeper parts of the lake to the shallower water. It spawns at night during the latter part of June and July.

Esox reticulatus (Le Sueur). Eastern Pickerel. This species migrates into the marsh with the Pike, but in much smaller numbers.

Esox lucius (Linn.). Northern Pike. The "run" begins with the disappearance of the ice in the spring. While the Inlet is still full of floating ice, the Pike are found along the shore in shallow water trying to make their way into the marsh. Here, during March and April, they spawn inlarge numbers. The young, which are extremely voracious, are found in the ponds throughout the marsh. The ecology of this form has been worked out in detail by Prof. G. C. Embody.*

Fundulus diaphanus (Le Sueur). Grayback. Not uncommon in the shallow water and open ponds.

Eucalia inconstans (Kirtland). Brook Stickleback. Formerly the Stickleback was very common in some cut-off pools along the railroad tracks, but during the summer of 1909 these pools dried up. It occurs occasionally in the Cove.

Percopsis guttatus (Agassiz). Trout Perch. During May and June it sometimes becomes quite common in the Cove. At other seasons it is of rather rare occurrence.

Labidesthes sicculus (Cope). Brook Silversides. Of not infrequent occurrence. Its habits and movements have not been observed.

Eupomotis gibbosus (Linn.). Common Sunfish. About the middle of May this fish comes into the shallow water of the marsh, and by the first of June there are numerous nests to be seen. The young are very abundant at all seasons.

Micropterus salmoides (Lacépède). Large-mouthed Black Bass. The young are frequently taken in the Cove, and with them occasionally the young of the small-mouthed species. The latter is more abunant elsewhere in the basin,where the bottom is rocky.

Perca flavescens (Mitchill). Yellow Perch. Small specimens are very frequently taken in the Cove during the spring. No regularity as to their occurrence has yet been noticed.

Boleosoma nigrum olmstedi (Storer). Tessellated Darter. Fairly common in the spring, and one of the few fishes that

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* Embody, G. C., "The Ecology of the Pike, *Esox lucius*." Ms.

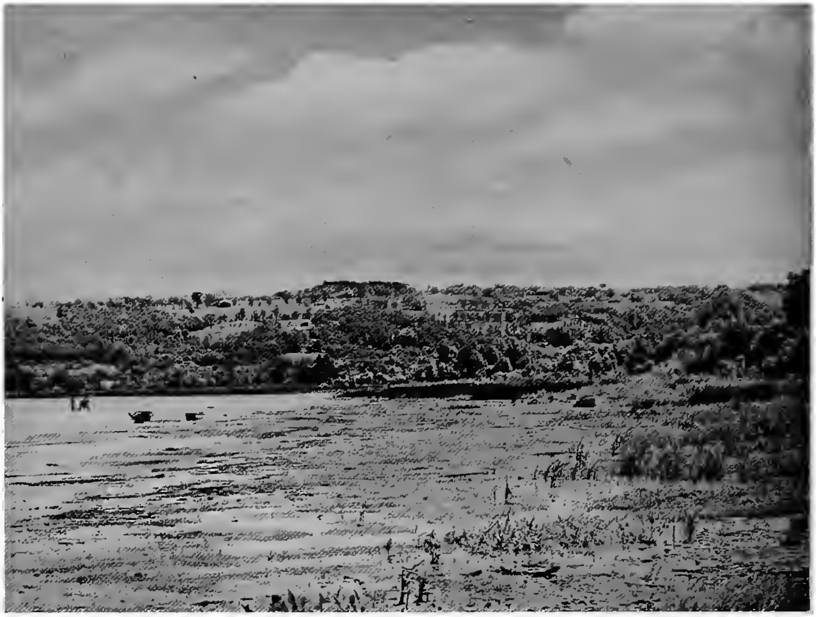


Fig. 1.—Head of Cayuga Lake, showing the Shore-line Association exposed during the drought of late summer.

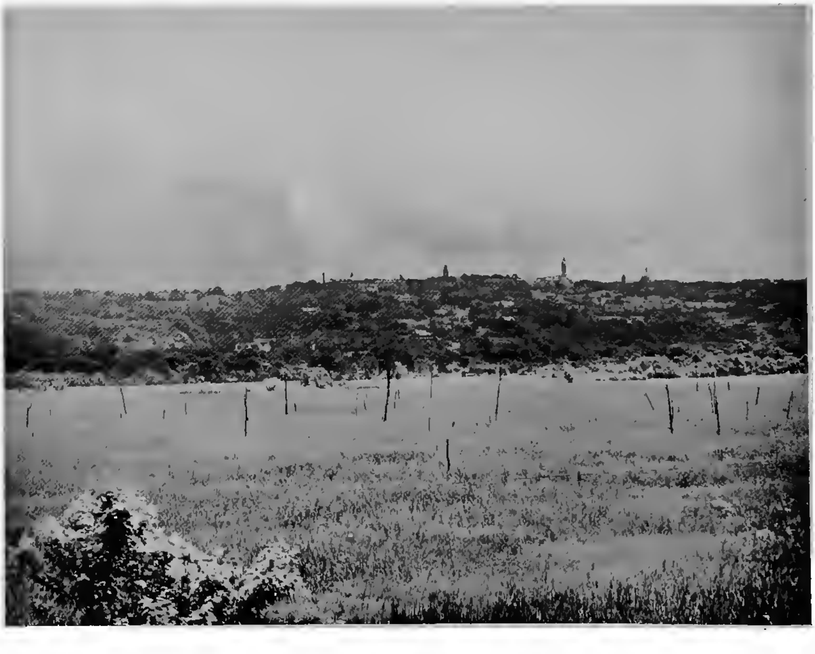


Fig. 2.—West Marsh, showing an extensive, uninterrupted area of the Cat-tail Association.

are found in the Cove in the late fall. Specimens from the Cove average larger than those from the creeks.

Of the Amphibia typical of this zone, there is a preponderance of the larval stages. *Necturus maculosus* is common in the creeks, and occasionally is taken in the Cove. *Diemictylus viridescens*, the only other aquatic adult, is found in marginal pools. One other species of the Urodela, *Ambystoma punctatum*, and eight species of Anura migrate to the swamp in the spring to deposit their eggs. Their larvæ, which throng the pools, properly belong to this zone. They are:

Bufo americanus (Le Conte)	American Toad
Hyla versicolor (Le Conte)	Common Tree Toad
Hyla pickeringii (Holbrook)	Peeper
Rana pipiens (Schreber)	Leopard Frog
Rana palustris (Le Conte)	Pickerel Frog
Rana clamata Daudin	Green Frog
Rana catesbiana Shaw	Bull Frog
Rana sylvatica Le Conte	Wood Frog

As a general rule, egg-laying and the appearance of tadpoles occur from a few days to a week earlier in the swamp than on the uplands.

Of the reptiles, the three that occur in the marsh belong more properly to the habitat next considered.

II. The Shore-line Association.

(Plate IV, fig. 1.)

This is a very complex association, and might well be divided into several lesser societies. Crowding out into the open water is a zone of bulrushes (*Scirpus validus*), very scattering at its outer edge but becoming much denser in the shallower water. Shoreward from this zone is a strip of burreed (*Sparganium*), water horsetail (*Equisetum*), arrowhead (*Saggitaria*) and water plantain (*Alisma*). Shoreward from this is an area of pickerel weed (*Pontederia*), arrow arum (*Peltandra*), water dock (*Rumex*), loosestrife (*Lysimachia*), and the like. The shore-line association forms a transition from the open water to the true marsh vegetation. In places the zonal arrangement is quite complete, in others, very fragmentary.

In the ecology of the birds this association occupies a much more immediate position than the first. In its outer portion, among the bulrushes, the Pied-billed Grebe finds the optimum for its existence. Here, upon a floating pile of debris, it deposits its eggs, and here it raises its young. In the inner stretches, where the vegetation is more dense, several birds are found nesting. Out into the burreed and *Equisetum* the Redwings and Rails extend their domain, while on the inner edge of the society the Marsh Wrens begin to nest and the Redwings and Rails occur more abundantly. The Coot and the Gallinule occasionally straggle thus far from the shelter of the cat-tails for their nesting sites. None save the Grebe, however, find here conditions best suited to their mode of life. Aside from giving shelter for nesting sites, it provides one of the best foraging grounds for most of the marsh birds, not in itself, but indirectly through the insect life which it supports. None of the plants of this zone—nor, in fact, any of the strictly marsh plants—supply forage for the birds, so far as observed. The seeds, which would be the natural food of many birds, are so protected by extremely thick seed-coats, as in the burreed and sedges, or by thick coatings of mucilaginous jelly, as in the arrow arum, that they are not available. The seeds that are utilized are those of plants which do not belong strictly to the marsh but to its border. However, in the pools and shallow water of this zone, on the leaves and in the tissues of the plants, are bred the numerous insects which furnish the primary food supply of most of the marsh birds during at least part of the year. Beetles of the genus *Donacia*, for instance, appear about mid-June in enormous numbers on the leaves of the burreed, and furnish almost the entire food supply of the Redwings at that season.

The characteristic mammal of this habitat is the Muskrat (*Fiber zibethicus*). Here it builds its houses, which are such characteristic sights along the rush-lined shores.

The fishes listed under the first association penetrate into this habitat but do not belong strictly to it, and therefore will be omitted here.

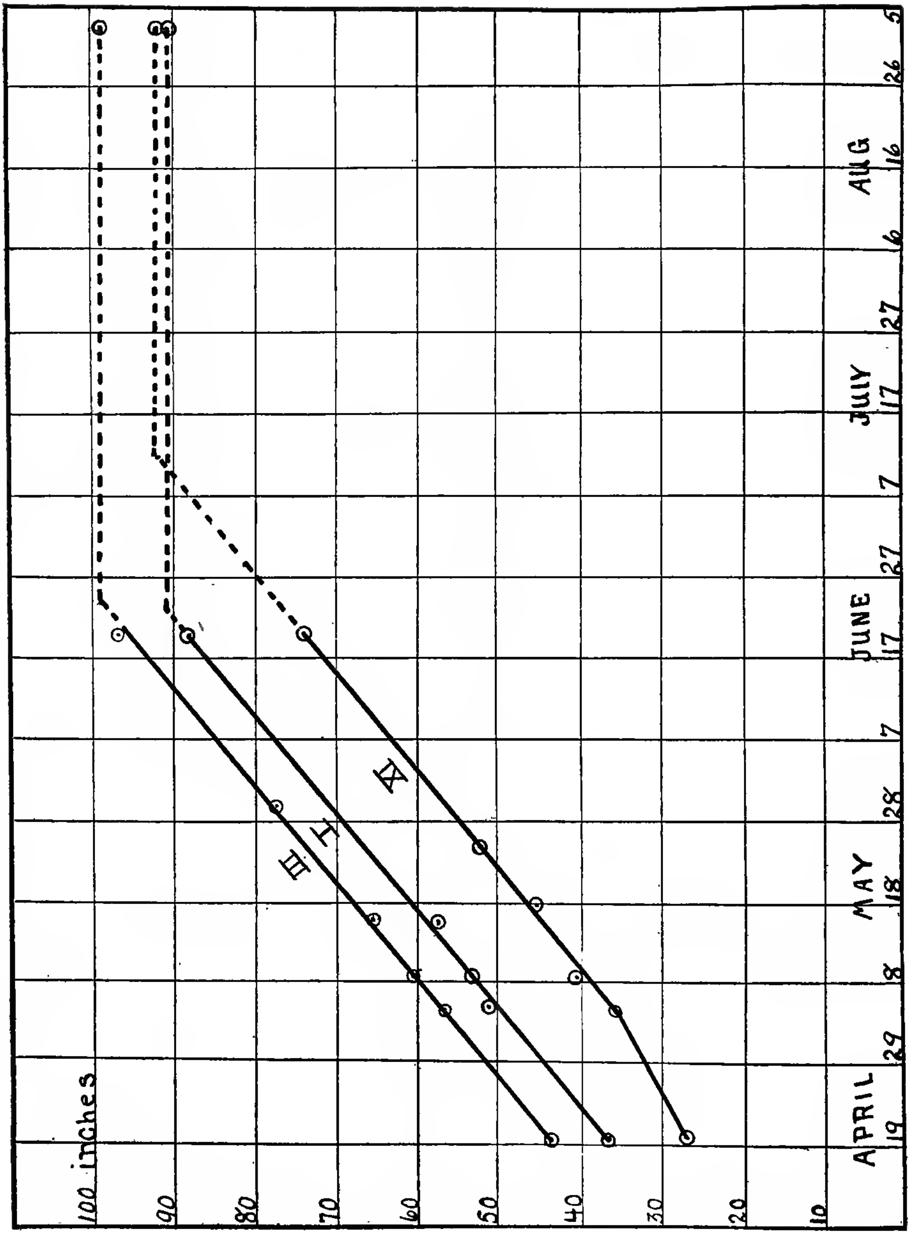
Of the Amphibia, the adults of certain species remain in the marsh throughout the year, and properly belong to this association. The Bull Frog (*Rana catesbiana*), of rare occurrence, is never found away from the water, nor is the more common Green Frog (*Rana clamata*). The Leopard Frog (*Rana pipiens*) and the Pickerel Frog (*Rana palustris*) leave the water, but are found throughout the rest of the marsh during the summer. The Peeper (*Hyla pickeringii*) and the Tree Toad (*Hyla versicolor*) leave the water for the bushes and trees during the summer and fall. The Toad and the Wood Frog, being terrestrial, likewise leave the water, and after the breeding season are found only in the drier situations. Adults as well as larvæ furnish food for certain of the birds and fishes. The Green Heron, the Night Heron, and the two Bitterns derive a large portion of their sustenance therefrom.

The reptiles which occur in the marsh belong properly to this association. There are but three: the Snapping Turtle (*Chelydra serpentina*), the Painted Turtle (*Chrysemys marginata*), and the Water Snake (*Natrix sipedon*). All come out of hibernation at about the same time, between the middle and the last of March.

III. THE CAT-TAIL ASSOCIATION.

(Plate IV, fig. 2.)

Not only is this association larger in extent than any of the others, but in it a single plant predominates to a greater degree than in either of the associations thus far considered. There are two species of cat-tail, *Typha latifolia* and *Typha angustifolia*, but the former is far more abundant. The two occur in very distinct patches, and seldom mingle. Within the association comparatively few other plants are found, but about the edges there is a mingling with the other societies, as would naturally be expected. In order to determine the rate of growth of *Typha latifolia*, stations were established at three points in the area surveyed where conditions seemed somewhat varied. Measurements were taken about once a week during most of the growing season (from April 20 to June 21), and again in the fall after growth had ceased. Curves of growth were drawn (Figure 1), and from them it is


100 inches
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MAY
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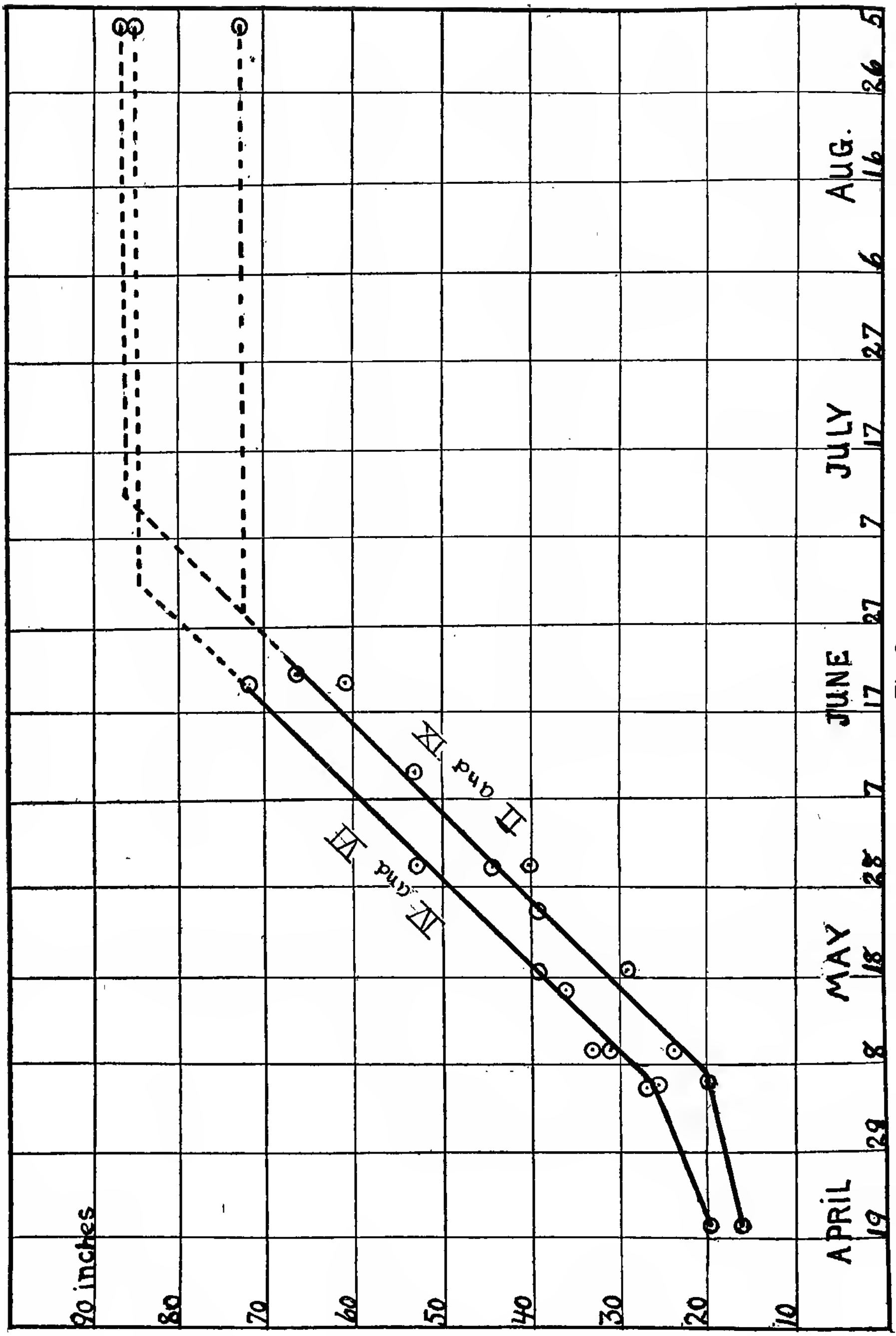
17
27
JULY
7
17
27
AUG
6
16
26
5
III
I
IV

readily discerned that the rate of growth was practically the same at each station—about one inch per day. Growth ceased in the latter part of June or early July, when a height of between 90 and 100 inches was reached. Certain differences which the curves present, and which may be due to variations in the depth of water, exposure, or other causes, would be a study in themselves, and will not be considered here.

This association furnishes the optimum conditions for several birds. About its edges, especially around the ponds, a majority of the Redwings hang their nests. The Coot, the Florida Gallinule, and the Least Bittern are more restricted to this habitat than are any of the other birds. The Virginia Rail and Sora, although showing no very marked preference for this habitat over the following, will be considered here. The Marsh Wren nests here in greater abundance than in the shore-line association, and occasionally the American Bittern also is found.

Of the mammals, there are none restricted to this habitat. The Weasels (*Mustela noveboracensis* and *M. cicognanii cicognanii*) and the Mink (*M. vison vison*) find here their best foraging ground, although they prefer the presence of a few fallen trees or stumps. Here one may find piles of fish skulls, amphibian bones, and the wings and feathers of marshbirds, which tell of the part played by these animals in the ecology of the marsh. Because of the absence of open water, the conditions here are not quite suited to the needs of the Muskrat. Frequently, however, by the clearing away of the roots of the cat-tails for the construction of its houses, small ponds are formed and the conditions of associations I and II are thus created. The Meadow Mouse is abundant here, and its nests are built just above the water line. Its habits in this environment are so different from its habits on the dry uplands, that its adaptations would be a study in themselves.

So far as forage is concerned, the cat-tails offer none except the insects they shelter. Of these, the most important are the weevils, the adults of which furnish a large part of the food supply of the Redwing at all seasons of the year.


90 inches
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MAY 8
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JUNE 7
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JULY 7
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27
AUG. 6
16
26
5
IV and VI
II and IX

Fig. 2.

IV. THE SEDGE ASSOCIATION.

(Plate VI, fig. 1.)

Here, as the name implies, the predominant forms of vegetation are the sedges. Several species occur, of which the most abundant is *Scirpus fluviatilis*. This association is nearly as pure as that of the cat-tails, and occupies areas nearly as extensive. In some places within the zone, such as the edges of ponds, the sedges are not firmly established, and numerous aquatic or semi-aquatic plants flourish. Many of those which make up the shore-line association are thus found scattered through the sedges. The rate of growth of *Scirpus fluviatilis*, determined as for the cat-tail at four stations, between May 6 and June 21, 1910, averaged slightly over an inch per day (Fig. 2). Previous to May 6, the growth was slow. It ceased, as in the case of the cat-tail, in the latter part of June or early July, when between 80 and 90 inches in height.

The birds most typical of this habitat are the American Bittern and the Swamp Sparrow, the latter being almost wholly restricted to it at the nesting season. The Marsh Wren, likewise, reaches its greatest abundance here. Of the other birds, the Redwing, the Rails, and occasionally the Coot and the Florida Gallinule, extend their nesting range from the previous zone into the sedges. The Song Sparrow and the Maryland Yellow-throat, in like manner, extend their range from the grass zone on the other side, and are found nesting with the Swamp Sparrow.

Among the mammals, the Jumping Mouse (*Zapus hudsonius*) probably reaches its maximum numbers in this zone. The Meadow Mouse continues to be very abundant, and the Star-nosed Mole (*Condylura cristata*) occasionally occurs.

The question of forage here repeats itself. The seeds of the sedges are occasionally found in the stomachs of the Redwing and the Rails, but, because of their exceedingly thick seed-coats, are probably used rather as grinding stones. The society is rich in insect life, however, and furnishes much of that type of food. The Marsh Hawk (*Circus hudsonius*), which might be included among the birds of this association, preys upon the Meadow Mice before the sedges become too high.

V. THE GRASS ASSOCIATION.

(Plate V, fig. 1.)

For want of a better term this has been called the grass association. It constitutes the transition from the marsh proper to the marsh border. It is characterized not only by a great variety of grasses, but by many of the Compositæ and such plants as the turtlehead, the vervains, and others that are typical of wet meadows. The following grasses are among those found here:

Bromus ciliatus L.
Calamagrostis canadensis (Michx.)
Elymus striatus Willd.
Glyceria nervata (Willd.) Trin.
Glyceria pallida (Torr.) Trin.
Glyceria acutiflora Torr.
Leersia oryzoides (L.) SW.
Phalaris arundinacea L.

The other more common species of plants are as follows:

Ambrosia artemisæfolia L.	Roman Wormwood
Ambrosia trifida L.	Giant Ragweed
Asclepias incarnata L.	Swamp Milkweed
Aster paniculatus Lam.	Panicled Aster
Aster novæ-angliæ L.	New England Aster
Bidens connata Muhl.	Swamp Beggar-ticks
Bidens cernua L.	Stick-tight
Chelone glabra L.	Turtlehead
Eupatorium perfoliatum L.	Boneset
Eupatorium purpureum L.	Joe-Pye Weed
Galium L. (several species)	Bedstraw
Impatiens pallida Nutt.	Pale Touch-me-not
Impatiens biflora Walt.	Spotted Touch-me-not
Lobelia cardinalis L.	Cardinal-flower
Lobelia syphilitica L.	Great Lobelia
Mimulus ringens L.	Monkey Flower
Myosotis scorpioides (True F.)	Forget-me-not
Phytolaca decandra L.	Scoke
Polygonum Hydropiper L.	Water Pepper

PLATE V.

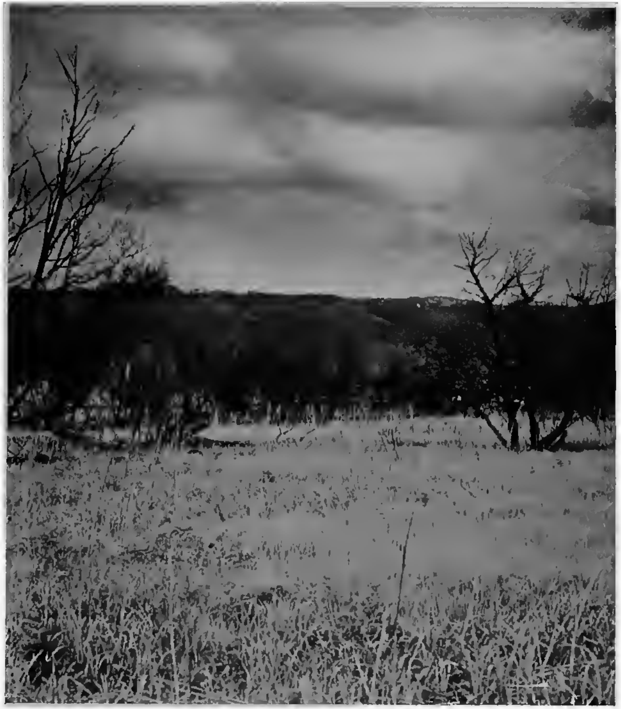

FIG. 1.—THE GRASS ASSOCIATION WITH THE ALDER-WILLOW IN THE BACKGROUND.

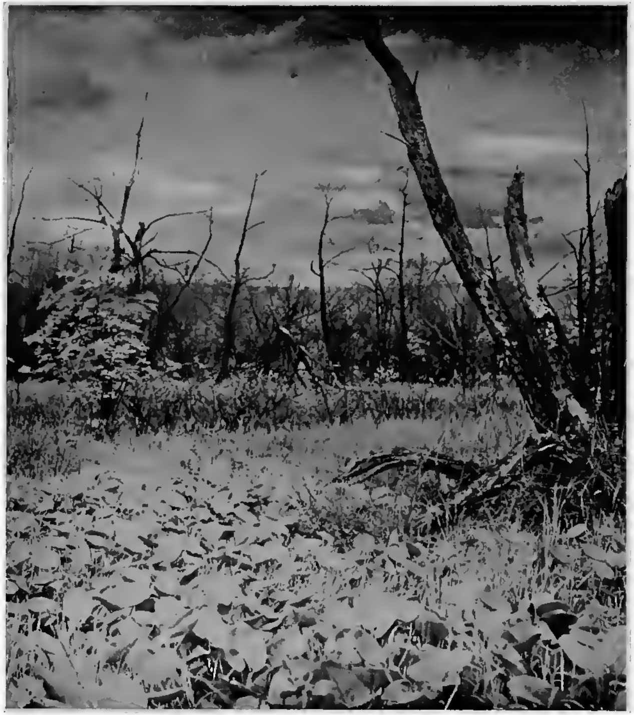

FIG. 2.—THE ALDER-WILLOW ASSOCIATION FRINGING A POND FILLED WITH SPATTER-DOCK.

Polygonum lapathifolium L.	Slender Pink Persicaria
Polygonum Persicaria L.	Lady's Thumb
Polygonum Convolvulus L.	Black Bindweed
Polygonum sagittatum L.	Arrow-leaved Tearthumb
Solanum Dulcamara L.	Bittersweet
Urtica gracilis Ait.	Nettle
Verbena hastata L.	Blue Vervain
Verbena urticæfolia L.	White Vervain

The birds characteristic of this habitat are few in number. The Maryland Yellowthroat and the Song Sparrow are the most typical; the Mourning Warbler, the Indigo Bunting, and a few others of varied habits sometimes nest here; and infrequently the Swamp Sparrow builds thus far away from the sedges.

Among the mammals, the Star-nosed Mole is the most typical species, but the Jumping Mouse and the Meadow Mouse occur abundantly. The Short-tailed Shrew (*Blarina brevicauda*) is found occasionally, but it belongs more particularly to the alder-willow and maple-elm associations. The Deer Mouse (*Peromyscus leucopus*) is found where there are stumps or fallen trees.

This association is quite rich as a feeding ground, especially in the fall and early spring, as long as there are seeds to be found, for the seeds of the varied assortment of plants occurring here are much more available for food than are those in the other societies.

VI. The Alder-willow Association.

(Plate V, fig. 2.)

This might well be considered as two societies, for the alders generally precede the willows in securing a foothold in the marsh. Ornithologically, however, it constitutes a unit. It includes, in addition to the alders and willows, a number of other plant forms, such as the skunk cabbage and the water arum. Toward the swamp, in the more aquatic situations, are the buttonbushes; on the other side, the red osier, wild rose, and meadowsweet. Many of the plants of the preceding zone also occur where the shade is not too dense. A few of the more important plants of the alder-willow association are here listed:

Alnus incana (L.) Moench.	Speckled Alder
Alnus rugosa (DuRoi.) Spreng.	Smooth Alder
Arisaema Dracontium (L.) Schott.	Green Dragon
Calla palustris L.	Water Arum
Cephalanthus occidentalis L.	Buttonbush
Cornus stolonifera Michx.	Red-osier Dogwood
Radicula Nasturtium-aquaticum (L.) Britton & Rendle	True Water Cress
Rosa carolina L.	Wild Rose
Ribes floridum L'Hér.	Wild Black Currant
Salix nigra Marsh.	Black Willow
Salix discolor Muhl.	Glaucous Willow
Spiræa salicifolia L.	Meadowsweet
Symplocarpus fœtidus (L.) Nutt.	Skunk Cabbage
Viburnum dentatum L.	Arrowwood

For the birds, this habitat constitutes a transition between the marsh and the uplands. The majority of them, such as the Catbird, Rose-breasted Grosbeak, and Yellow Warbler, are upland birds which are crowding into this part of the swamp. The only birds truly typical of this habitat are the Alder Flycatcher and the Green Heron. In the region under consideration, the Redwing only occasionally leaves the cat-tails and sedges for the alders. A list of the birds that have been found nesting in this habitat follows:

Butorides virescens	Green Heron
Zenaidura macroura carolinensis	Mourning Dove
Coccyzus americanus	Yellow-billed Cuckoo
Coccyzus erythrophthalmus	Black-billed Cuckoo
Dryobates pubescens medianus	Downy Woodpecker
Archilochus colubris	Ruby-throated Hummingbird
Tyrannus tyrannus	Kingbird

PLATE VI.

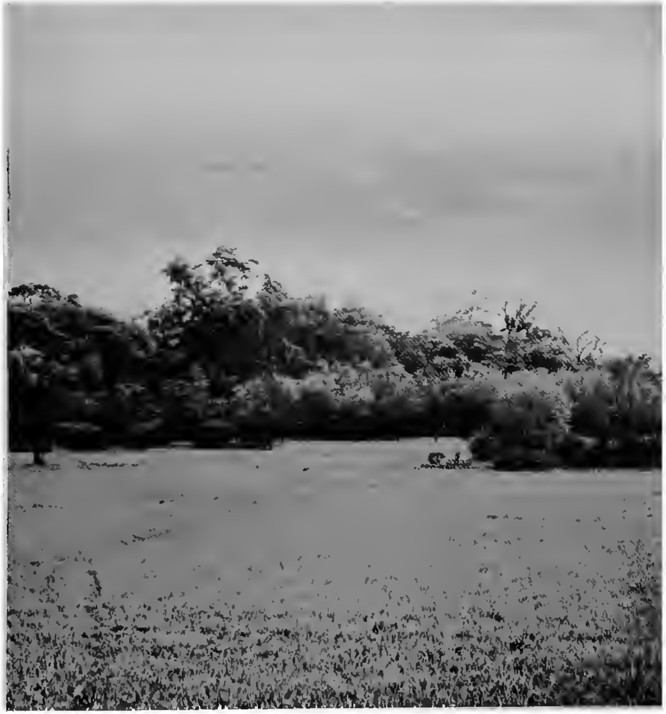

FIG. 1.—THE SEDGE ASSOCIATION WITH THE MAPLE-ELM IN THE BACKGROUND.

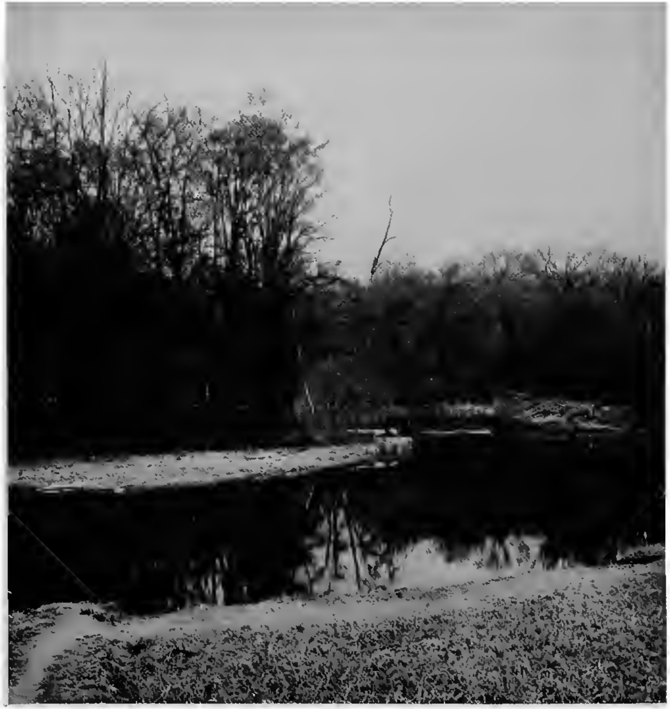

FIG. 2.—THE MAPLE-ELM ASSOCIATION AND FALL CREEK.

Myiochanes virens	Wood Pewee
Empidonax trailli alnorum	Alder Flycatcher
Empidonax minimus	Least Flycatcher
Corvus brachyrhynchos	Crow
Molothrus ater	Cowbird
Icterus galbula	Baltimore Oriole
Quiscalus quiscula æneus	Bronzed Grackle
Astragalinus tristis	Goldfinch
Spizella passerina	Chipping Sparrow
Melospiza melodia	Song Sparrow
Zamelodia ludoviciana	Rose-breasted Grosbeak
Iridoprocne bicolor	Tree Swallow
Bombycilla cedrorum	Cedar Waxwing
Vireosylva olivacea	Red-eyed Vireo
Vireosylva gilva	Warbling Vireo
Lanivireo flavifrons	Yellow-throated Vireo
Dendroica æstiva	Yellow Warbler
Setophaga ruticilla	Redstart
Dumetella carolinensis	Catbird
Penthestes atricapillus	Chickadee
Hylocichla fuscescens	Veery
Planesticus migratorius	Robin
Sialia sialis	Bluebird

This habitat furnishes little forage for the true marsh birds, but a few that pass the winter find shelter in it. The Redwings take refuge here upon their first arrival in the spring, and during both spring and fall it throngs with other migrants.

VII. The Maple-elm Association.

(Plate VI, fig. 2.)

The maple-elm association forms the climax society in the swamp. The silver maple and the black ash, which are the first to gain a foothold, are followed by the sycamore, the butternut, and finally the elm. The latter tree at present makes up the greater part of the wooded area on the eastern side of the marsh (Plate I). This association includes several minor societies, which will not be considered here, and furnishes a habitat for a large number of birds. Those which have been found breeding here are given in the following list, which is arranged in ecological groups:

1. Birds that Nest in the Tree Tops.

Ardea herodias	Great Blue Heron*
Nycticorax nycticorax nævius	Black-crowned Night Heron*
Buteo lineatus	Red-shouldered Hawk
Corvus brachyrhynchos	Crow
Icterus galbula	Baltimore Oriole
Vireosylva gilva	Warbling Vireo

2. Birds that Nest in the Trunks of Trees.

Aix sponsa	Wood Duck
Falco sparverius	Sparrow Hawk
Otus asio	Screech Owl
Dryobates villosus	Hairy Woodpecker
Dryobates pubescens medianus	Downy Woodpecker
Melanerpes erythrocephalus	Red-headed Woodpecker
Colaptes auratus luteus	Northern Flicker
Myiarchus crinitus	Crested Flycatcher
Iridoprocne bicolor	Tree Swallow
Troglodytes aëdon	House Wren
Sitta carolinensis	White-breasted Nuthatch
Penthestes atricapillus	Chickadee
Sialia sialis	Bluebird

3. Birds that Nest on the Lower Branches.

Zenaidura macroura carolinensis	Mourning Dove
Archilochus colubris	Ruby-thorated Hummingbird
Tyrannus tyrannus	Kingbird
Myiochanes virens	Wood Pewee
Empidonax minimus	Least Flycatcher
Molothrus ater	Cowbird
Quiscalus quiscula æneus	Bronzed Grackle
Astragalinus tristis	Goldfinch
Spizella passerina	Chipping Sparrow

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* Nests in the marshes at the north end of Cayuga Lake, but not at Ithaca.

Piranga erythromelas	Scarlet Tanager
Bombycilla cedrorum	Cedar Waxwing
Vireosylva olivacea	Red-eyed Vireo
Lanivireo flavifrons	Yellow-throated Vireo
Hyloichla mustelina	Wood Thrush
Planesticus migratorius	Robin

4. Birds that Nest in the Undergrowth.

Coccyzus americanus	Yellow-billed Cuckoo
Coccyzus erythrophthalmus	Black-billed Cuckoo
Zamelodia ludoviciana	Rose-breasted Grosbeak
Passerina cyanea	Indigo Bunting
Dendroica æstiva	Yellow Warbler
Oporornis philadelphia	Mourning Warbler
Setophaga ruticilla	Redstart
Dumetella carolinensis	Catbird

5. Birds that Nest on the Ground.

Melospiza melodia	Song Sparrow
Geothlypis trichas	Maryland Yellowthroat
Hylocichla fuscescens	Veery

The mammals which have been found typical in this habitat are:

Sciurus hudsonicus loquax Bangs	Southeastern Red Squirrel
Sciuropterus volans Bangs	Southern Flying Squirrel
Peromyscus leocopus noveboracensis (Fischer)	Deer Mouse
Sylvilagus floridanus mearnsi (Allen)	Eastern Prairie Cottontail
Mephitis putida Boitard	Southeastern Skunk
Procyon lotor (L.)	Raccoon
Blarina brevicauda (Say)	Short-tailed Shrew

The bats, mentioned under Association I, spend the days for the most part suspended in the trees of this association. The Weasels, the Mink, the Star-nosed Mole, the Meadow Mouse, and the Jumping Mouse extend more or less into this habitat.

As a foraging ground and shelter, the maple-elm association is of comparatively little importance to the strictly marsh birds, except in the case of the Redwing. In the spring and fall migrations, during the period of fall flocking, and even during the breeding season, many Redwings are found feeding in the trees and clearer portions of the woods.

The vegetation is that typical of lowland woods. A list of the more abundant forms follows:

TREES.

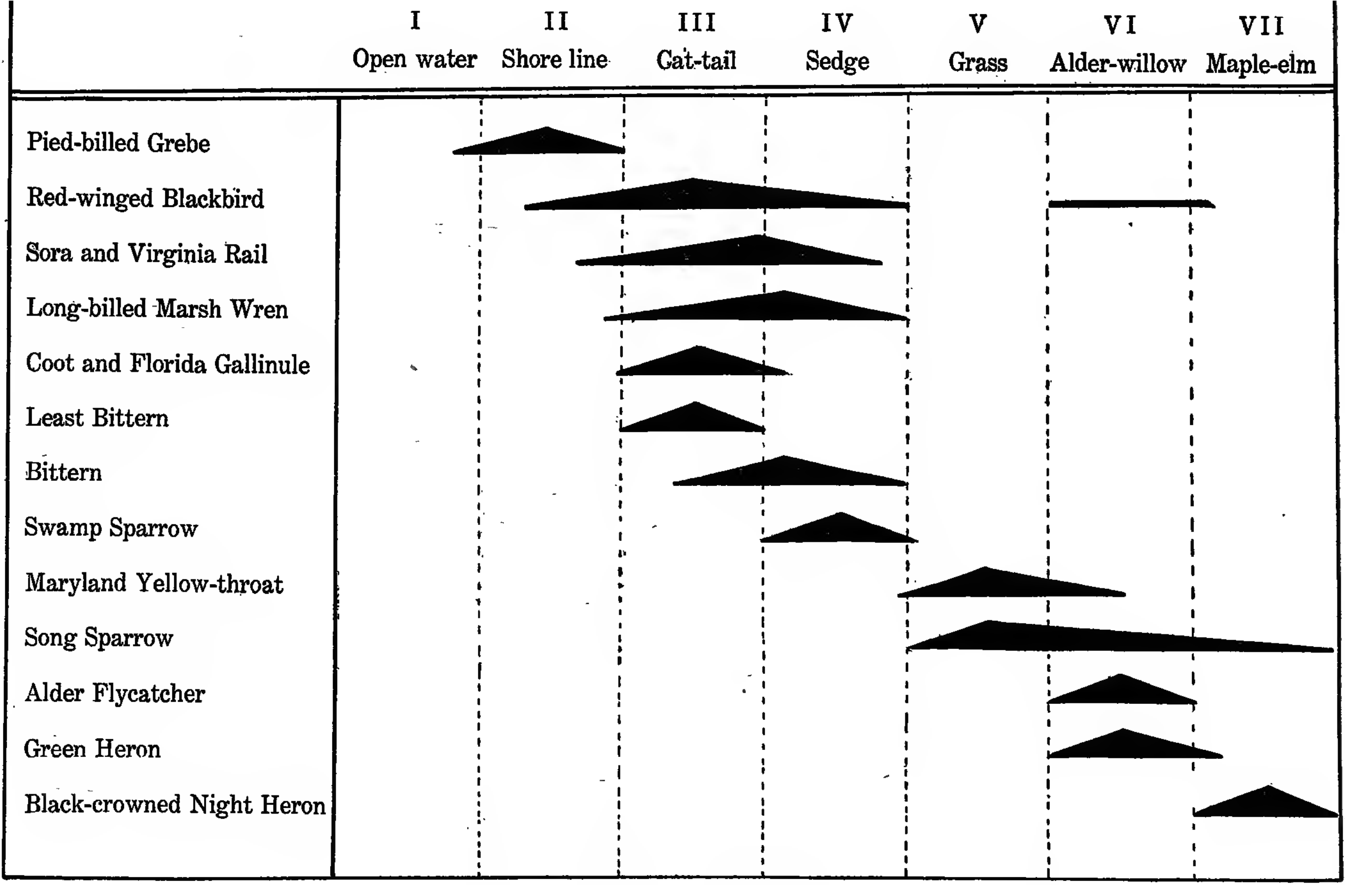
Acer saccharinum L.	Silver Maple
Celtis occidentalis L.	Sugarberry
Fraxinus americana L.	White Ash
Fraxinus nigra Marsh	Black Ash
Juglans cinerea L.	Butternut
Plantanus occidentalis L.	Sycamore
Quercus bicolor Willd.	White Oak
Salix fragilis L.	Crack Willow
Salix nigra Marsh	Black Willow
Tilia americana L.	Basswood
Ulmus americana L.	American Elm

BUSHES AND VINES.

Benzoin æstivale (L.) Nees.	Spice Bush
Cornus stolonifera Michx.	Red-osier Dogwood
Ribes floridum L'Hér.	Wild Black Currant
Sambucus canadensis L.	Common Elderberry
Rhus Toxicodendron L.	Poison Ivy
Vitis vulpina L.	Frost Grape

HERBACEOUS PLANTS.

Allium tricoccum Ait.	Wild Leek
Ambrosia trifida L.	Giant Ragweed
Angelica atropurpurea L.	Angelica
Cardamine bulbosa (Schreb.) BSP.	Spring Cress
Dentaria diphylla Michx.	Two-leaved Toothwort
Dentaria laciniata Muhl.	Cut-leaved Toothwort
Galium L.	Bedstraw
Nepeta hederacea (L.) Trevisan	Ground Ivy



ZONAL DISTRIBUTION OF MARSH BIRDS.

Heracleum lanatum Michx.	Cow Parsnip
Impatiens biflora Walt.	Spotted Touch-me-not
Impatiens pallida Nutt.	Pale Touch-me-not
Polyganum virginianum L.	Virginia Knotweed
Symplocarpus fœtidus (L.) Nutt.	Skunk Cabbage
Urtica gracilis L.	Stinging Nettle
Laportea canadensis (L.) Gaud.	Wood Nettle
Viola papilionacea Pursh	Purple Violet

A general summary of the distribution of the most typical marsh birds, showing where each finds its optimum conditions for nesting, is shown in Plate VII. The extent of range is indicated by the length, and the optimum conditions by the greatest width, of the black lines.

SUCCESSION.

Even the most casual observer who has had opportunity to revisit a marsh after a short absence, is struck with the changes that have taken place. One cannot help noticing that conditions are far from static. Aside from such radical changes as occur when a stream alters its course, or when a barrier breaks and produces a flood, there are certain forces always acting, which place each association under a sort of tension. These forces are the struggle for existence and, especially, the struggle for the perpetuation of kind. Each zone tends by its growth to increase the area which it occupies, and therefore crowds upon some other society. The bulrush, extending further and further from shore, gains a foothold where before it was impossible for it to live. The tangle of its roots and the denseness of its growth, which naturally follow nearer the shore, furnish the shelter which is necessary for the life of the other plants of the shore line. These in turn crowd into the bulrushes, and even by so doing render conditions more favorable for themselves and less so for the former occupants. The innermost of the bulrushes die, and that zone has been crowded forward. While this has been in progress, a similar struggle has been going on between the vanguard of the cat-tails and the rear guard of the shore-line association, resulting in the crowding of the latter further from the shore.

The cat-tail association has, by its own growth, built up a firmness of soil that gives the sedges the conditions necessary for their occupancy. Thus the story goes on. The climax society is that of the elms, the society which, if left undisturbed, would eventually conquer the entire marsh. The zones of plant life are very evident, and the method of succession comparatively simple. In the case of the animals, other factors enter, and conceal the order of progression, which nevertheless exists as with the plants. An area occupied by Grebes to-day may be occupied by Rails to-morrow. As the sedges encroach upon the cat-tails, so the Swamp Sparrows crowd upon the Rails. A detailed understanding of the succession requires years of close observation, and the results to be derived from such observation are, of course, not yet forthcoming. It was with this in view that the map of the area under consideration was made. By following it from year to year, it is hoped that a more definite knowledge of the succession will be gained.

PART II. THE LIFE HISTORY AND ECOLOGY OF THE RED-WINGED BLACKBIRD.

The order of this discussion will be that of the various phases of the life history of the bird. Beginning with the spring migration, we shall consider in turn mating, nesting, flocking, fall migration, and other general phases not included in the above, such as enemies, plumage, and food. Each division will be prefaced with a summary of the principal literature upon the phase under consideration, and will include a discussion of the changes occurring in the environment during that period.

Spring Migration.

Summary of the Literature.—In view of the general interest that is taken in this phase of a bird's life history, remarkably little definite information concerning the Redwing's migration has been published. According to Wilson (1831), the species is migratory north of Maryland. It is "found during winter in immense flocks, sometimes associated with Purple Grakles,

. . . along the whole lower parts of Virginia, both Carolinas, Georgia and Louisiana, particularly near the sea coast. . . . About the twentieth of March, or earlier if the season be open, they begin to enter Pennsylvania in numerous tho small parties. The migrating flocks are usually observed from daybreak to eight or nine in the morning, passing to the north, chattering to each other as they fly along. . . . They continue in small parties to frequent the low borders of creeks, swamps and ponds, till about the middle of April, when they separate in pairs to breed." Nuttall (1840) observes: "From the beginning of March to April, according to the nature of the season, they begin to visit the northern states in scattered parties, flying chiefly in the morning." Samuels, in 1867, states: "It arrives [in New England] in small flocks, the males preceding the females a week or ten days. On its arrival, it frequents the meadows and swamps, where, from early dawn to twilight, its song . . . is heard."

Warren (1890) observes that they arrive in Pennsylvania about March 20, the males a few days in advance of the females. Loomis (1892) tells us that in Chester County, S. C., "Unless the season is backward, by the first week [in February] . . . Red-winged Blackbirds are found with increasing regularity," and by "the middle of the month . . . the hosts of Robins and Blackbirds . . . arrive, and females become more numerous." Stone, in 1894, placed the date of spring arrival in Pennsylvania much earlier than either Wilson or Nuttall, stating, "abundant summer resident, arriving in the vicinity of Philadelphia on the first spring-like day, sometimes as early as February 6."

Merrill (1898) states that at Fort Sherman, Idaho, it is "One of the first migrants to appear, as I have seen it on February 22. After remaining two or three weeks these early birds seem to pass on to the north and none are seen until about the first of May, when others, apparently the birds nesting here, arrive."

Libby (1899, Wisconsin), in his studies of the nocturnal flight of migrating birds, says: "More Swamp Blackbirds were identified than any other." Hoffman (1904, New England) puts the time of arrival of the females as three weeks later than that of the males. Baird, Brewer, and Ridgway (1874) tell us that "Early in March these large assemblies break up. A part separate in pairs and remain among the Southern swamps. The greater portion, in smaller flocks, the male bird leading the way, commence their movements northward. . . . They are among the earliest [in New England] to arrive in spring, coming, in company with the Rusty Grakle, as early as the 10th of March. Those which remain to breed usually come a month later." Townsend (1905, Massachusetts) gives us a hint as to their habits during the migration by stating: "The greatest number are to be found in the late afternoon, as during the day, they are foraging in the upland fields."

Brewster (1906) gives the earliest record for Cambridge as February 26, 1866, with March 16 as the normal date. He then gives us more definite information as to their movements than any one prior to this time. "For several weeks after their first appearance in early spring Redwings are usually found in flocks composed wholly of males. At this season they are seldom seen about their breeding grounds excepting in the early morning and late afternoon. At most other hours of the day they frequent open and often elevated farming country, where they feed chiefly in grain stubbles and weed-grown fields. . . . After the female Redwings arrive (I seldom see them before the first week of May) the males spend most of the time with them in the swamps and marshes, but even at the height of the breeding season it is by no means unusual to find birds of both sexes feeding, in flocks, in dry, upland fields." This is by far the most detailed and accurate account that has been found. As far as it goes, it agrees with the observations made at Ithaca except, perhaps, for the time of the appearance of the females. Very different is the account of its habits given by Max M. Peet (1908) in Michigan. He observes in part: "It is worthy of note that during this period [spring] the red-wings are seldom met with outside of the marsh and so must procure the bulk of their food in it."

To summarize what has been written concerning its spring migration, it may be stated that, beginning its northward movement from the Southern States in February, it reaches Pennsylvania during the first of March, although birds have been recorded as early as February 6. It reaches Massachusetts normally about the tenth of the month. The males precede the females by from several (Wilson) to as many as fifty (Brewster) days. The first birds to arrive are not the breeding birds, but are followed by the latter after an interval of from two or three weeks to a month. They migrate chiefly during the early morning, but have been recorded as traveling at night. They forage principally over the uplands, and roost in the marshes.

Spring Migration at Ithaca.—Although the Redwings have been observed chiefly from points of vantage in the marsh, frequent notes as to their movements elsewhere have been made. Several trips each week (and often daily trips) were made to the marsh, and the movements of the birds were watched from their first appearance in the afternoon until after dusk. Again in the morning, from dawn until their flight to the uplands, they were studied through two successive seasons. The collection of numerous specimens made it possible to satisfy any doubts relative to age or sex. Conclusions based upon observations of their movements have been reinforced by studies of the food taken from stomachs.

The normal migration can be divided into seven periods according to sex, age, and nature of the birds (whether resident or migrant), as follows:

1. Arrival of "vagrants."
2. Arrival of migrant adult males.
3. Arrival of resident adult males.
4. Arrival of migrant females and immature males.
5. Arrival of resident adult females.
6. Arrival of resident immature males.
7. Arrival of resident immature females.

Arrival of "Vagrants."—Here, as recorded in Pennsylvania by Stone, the first warm days of spring bring the first Red-winged Blackbirds, although the marshes may still be frozen solid, and the ground covered with snow. These I have termed "vagrants," because they are supposed not to represent the beginning of the true migration, but to be individuals which have wintered not very far to the south. These birds are not recorded every year, but when they do appear, they are noted in February. In 1906 they were first recorded on February 24, in 1909 on February 22, and in 1911 on February 25. In 1907, 1908, and 1910, they were not recorded. They precede the true migrants by an average of 13 days. The "vagrants" are for the most part adult males, but immature males or females may be found among them. They are never in large flocks, and often occur singly. The reproductive organs are very small, especially in the case of immature birds (Plate XXI, *A*), in which they have scarcely begun to enlarge. They differ from the next migrants to arrive, in that they frequently linger about the marsh in the daytime and seem in no hurry about their migration. They sometimes remain until the true migrants arrive, although usually there is a well-defined interval between their departure and the arrival of the next group. Their food at this time is almost entirely animal, consisting of weevils, lepidopterous larvæ and pupæ, and ground beetles, which they secure for the most part in the alder-willow zone. They do not frequent the open marsh.

Arrival of Migrant Adult Males.—The first true migrants arriving in the spring are adult males. They appear in flocks, some of which contain a hundred or more birds, and ordinarily are first noted in the marsh, although occasionally seen in tree tops or stubble fields on the uplands. The average date of arrival from 1906 to 1911 was March 9—nearly two weeks after the arrival of the "vagrants." By this time the ice has usually disappeared from the streams, and the marsh is flooded (Plate I, fig. 1). The fires of the fall and winter have left merely the half-burned, sharply pointed stubble projecting above the water, so that in the open marsh shelter is very scant. Birds and organisms of all kinds are exceedingly scarce. A few early Pike have begun to splash, but there are few other signs of spring.

At this season of the year, about 4.30 in the afternoon, let us take a stand at the upper end of the marsh and gaze

FIG. 1.—MIGRATING REDWINGS, ILLUSTRATING THE IRREGULAR FORM OF THE FLOCK.

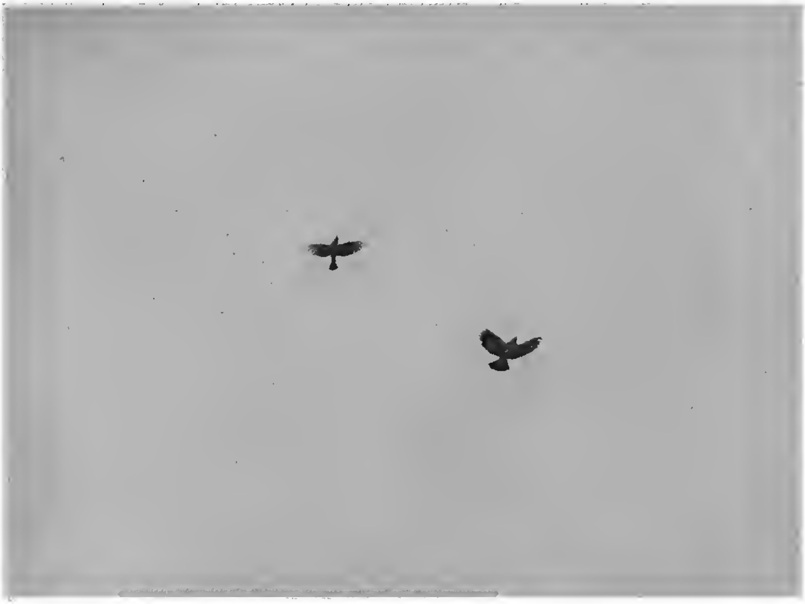


FIG. 2.—A PAIR OF REDWINGS HOVERING ABOVE THE NEST.

southward up the Inlet Valley. Presently we discern what appears like a puff of smoke in the distance, drifting in at a considerable height. After a minute or two the smoke is resolved into an aggregation of black specks, and then, as it drops lower and lower, it takes on that irregular form so characteristic of the flocks of Red-winged Blackbirds (Plate VIII, fig. 1). With one last swoop and flutter of wings, they alight on the more prominent of the few scraggly trees at the southern end of the marsh. The migration has begun. For a few moments they shake out their feathers and give vent to their feelings in song. It is but a short time, however, before they start again for the north. As they pass over the marsh, individuals drop from the ranks and float down to projecting branches or cat-tails, but the main body continues on its way to the lake, where it rises and swings to the west; then gaining the brow of the hill, it turns once more on a northward course. Meanwhile, other flocks appear and repeat the same maneuvers. These are followed by others, until the marsh is well populated with birds that have dropped from the migrating flocks. The marsh resounds with their songs. These might be thought of as resident birds selecting this marsh as their abode for the year, but such is not the case. Many of them make their way by short flights to the north end of the marsh, where considerable flocks gather in the willows along the lake shore. Then, as a migrating flock passes over, they fly up and join it, and are again on their way toward their more northern homes. Occasionally a flock, upon reaching the lake, swings to the east and continues along that side of the lake, but the majority hold to the west. The first flocks to arrive in the evening come from the south and drop in from a considerable height, but as it grows later, they are seen flying lower and lower until the last barely skim the hills. These flocks do not come from the south, but from the southeast and east. They are more compact, and are intent upon but one thing—the finding of a place to roost. The place selected is a spot where the flags are not quite so completely burned and a little more shelter is afforded. Toward this spot, as if with some previous knowledge of its location, all of these later flocks direct their flight, and disappear into the cat-tails. The birds scattered over the marsh assemble in the same place, and all spend the night together.

Every available perch, not so high as to be conspicuous, is filled with birds down to the water's surface, but were it not for the unspeakable din that arises from the hundred of throats, one would scarcely be aware of their presence, so inconspicuous are they against the dark water. If one disturbs them now, there is a rush of wings, but they do not fly far. Raillike they drop back into the marsh a short distance away, and soon resume their indescribable discord. As night falls, their notes become more subdued. A little crowding now and then brings forth a few scolding notes, or the sudden crackling of a flag under its unaccustomed weight startles a cry from some frightened bird, but otherwise all is quiet. And so it remains until the next morning. Unlike most of the marsh birds, they are seldom heard during the night.

The next morning the evening's performance is reversed, and the procedure during each day of the migration is practically the same. A month later, when other birds have arrived, the comparative times of awakening and periods of activity of the various marsh birds are better observed. At this time the Song Sparrows are singing by four o'clock, and the Swamp Sparrows a few minutes later. The stars are still bright when a Short-eared Owl is heard giving its peculiar call and is dimly seen as it circles near. The Sparrows continue to sing. It is 4.25 A.M., and the first Bittern awakes and sounds its liquid notes across the marsh. The Gulls are heard on the lake, and ten minutes later the Wilson's Snipe begin to bleat and perform their aerial evolutions. The Gulls start up the valley for their daily skirmishing in the fields. It is fully three-quarters of an hour since the first Song Sparrow was heard, the morning star has sunk below the horizon, the first signs of dawn have long since appeared, and now the first Redwing is heard. As though awaiting the signal, a hundred birds give answer, and day is announced. The stars die out and color appears in the east; the greens and yellows change to rose, and the rose to red. A Great Blue

Heron leaves his roost in the woods and starts for his fishing grounds. A pair of Teal swing through the field of vision, dark against the sky. A few restless Grackles start from the marsh, heading for the hill, and soon the morning flight of Redwings has begun. Scattering over the marsh, they do not leave in the compact flocks that are so characteristic of the evening flight. Single birds, more uneasy than the rest, loose groups of seven or eight, or at times slightly larger flocks, start for the hills to the east and to the west. By eight o'clock most of the birds have left, and two hours later one would scarce know there had been a Redwing in the marsh.

Following these scattered birds as they leave, one finds some of them continuing to the east, often for considerable distances and high in the air, as though retracing their flight of the preceding evening before swinging to the north. Others continue up the west shore of the lake, as did the majority of the early flocks on the evening flight, but most of them do not fly far before alighting to feed. During the day, by alternate periods of feeding and short flights, they continue in a general northerly or northwesterly direction until late afternoon. Then ensues a more prolonged flight which is the real migration of the day. This continues until almost dusk, when a straight line is made for the nearest marsh. As they pass over fields where other Redwings are feeding, the latter answer their calls and fly up to join them. This may be repeated many times before the arrival at the marsh, single birds collecting into small groups, and the groups into large flocks. During the fall migration the birds frequently retrace their flight to a greater or less extent, in order to reach the proper shelter, and are seen coming into the marsh at nightfall from the south. In the spring, however, they have not been observed (at Ithaca) to change the direction of flight except to a northwesterly or westerly direction; at this season they come into the marsh, as has been stated previously, from the east and southeast as well as from the south. In case a marsh is reached some time before nightfall, they may linger, but the majority continue on their way north until nearly dusk.

This period of the migration, which I have termed the arrival of *migrant adult males*, continues for about two weeks before the *resident* birds begin to arrive. Each evening there is a well-defined flight into the marsh; each night the birds all roost together; and each morning they all leave for the north. The marsh to them at this period is a shelter for the night only, and the entire day is spent on the uplands. Frequently there is a lull of a few days when there are no birds migrating, and at this time none will be found in the marsh even at nightfall. The marsh is still flooded, and the vegetation has not yet started (Plate I, fig. 1).

Arrival of Resident Adult Males.—The arrival of resident males is first made clear by the actions of the birds themselves. To one unfamiliar with their habits the *exact* time of arrival is not apparent. Up to this time the birds, for the most part, have kept in more or less well-defined flocks. They have been difficult to approach, the slightest annoyance starting them off. The birds scattered over the marsh have not confined themselves to one area, and the slightest disturbance has frightened them to some other part, or has caused them to leave the marsh altogether. About the end of March, however, certain birds arrive, in whose actions a difference is noticed. They do not fly away at one's approach, or, if frightened, soon return to the same spot. These birds do not associate with the migrating flocks, and they roost alone. If one is enabled to identify an individual bird among them by such characteristics as abnormal feet or the loss of its tail or a primary feather, as has frequently been done in this study, one finds that it never changes its station in the marsh after its arrival. Appearing about the last of March, these resident males establish themselves at what are believed to be their former nesting sites. To these spots they partake themselves each afternoon, and from them they depart each morning to the uplands where they feed during the day. Whatever time is spent in the marsh, is spent at this station and nowhere else. Many times between four and six o'clock in the afternoon, "marked" birds have been observed to enter the marsh along with small groups of companions, which they soon left, proceeding directly to their chosen sites. The next morning, between eight and ten, they have been observed leaving the marsh for the day. The resident birds generally delay their departure in the morning until practically all of the migrating birds have left. In like manner they return in the afternoon before the migrating individuals arrive. As the season advances, the time spent on the uplands becomes shorter, until by the middle of April, when the first of the resident females appear, these resident males are spending the entire day in the marsh. From their first arrival, they assume all rights to the domain in which they have established themselves. Frequently these domains adjoin one another closely, but the birds seldom trespass on one another's rights. When they do so, they seem to recognize the owner's prerogative, so that serious quarrels never ensue.

A consideration of their food at this season (see page 120) shows that it partakes of both a marsh and an upland character. Of the marsh food (Plate XVIII, fig. 2) there is no great variety, for insects are still scarce and in the open marsh there are no available seeds whatsoever.

At the time of the arrival of these resident birds, the level of the water in the marsh has fallen considerably, and the Inlet no longer overflows its banks. The vegetation has started its growth, but it not yet visible above the surface of the water. The Pike are at the height of their spawning season, and the Spotted Salamander, Wood Frog, and Leopard Frog are depositing their eggs.

Arrival of migrant females and immature males.—The resident males have been at their stations but a few days before the first females and immature males appear among the migrating flocks, for the last days of March and first of April usually usher them in. The first females recorded are generally single birds traveling in company with the adult and immature males. At this time the males pay no attention to them. Many Cowbirds, Bronzed Grackles, and Rusty Blackbirds are now mingled in the flocks of Redwings, as each species has been, more or less, since its first appearance. Within a few days, as their numbers increase, small flocks made up entirely of females are observed. It is about this time—the end of the first week in April—that the males being to show a slight interest in the presence of the females. The former now spend more of their time in the marsh, and resent intrusion into their domains. By this time their reproductive organs show considerable increase in size (Plate XXI, *E*). Among the migrating birds at this time there is an increasing preponderance of immature males and of females. The latter shun the presence of the males, and whenever they do approach one of the residents, they are immediately driven off. A flock of fifteen females has been observed to be dispersed by a single male and actually prevented from alighting in the marsh undisturbed. This flock, after circling about the marsh and attempting to alight several times, was finlly forced to leave.

Arrival of resident adult females.—During the early part of the third week in April, another group of females arrives. The flocks break up and the single birds scatter over the marsh, as did the resident males upon their first arrival. Usually they select a place near some male or group of males. They are much more retiring than the latter, however, and keep mostly near the water's surface, where they are inconspicuous. Whenever they appear on the tops of the cat-tails, or more especially, when they attempt to fly, they are immediately pursued by one or more of the males. Occasionally a male drives a female in great circles over the marsh and even to a considerable height. Eventually, however, he relinquishes the pursuit and returns to his post. The earlier migrant females, when pursued in this way, immediately leave the marsh. But now, as the male ceases pursuit, the female checks her flight and is soon again at her station near the male. Such maneuvers announce the arrival of the resident females. The resident males now remain the entire day in the marsh. The females at first leave the marsh during the middle of the day, but return to the same spot each night. Occasionally a female is found to have selected a spot near a male, and for some reason remains unmolested or even scarcely noticed by him. Ordinarily she is persistently persecuted, and can not appear above the cat-tails without being pursued. She always returns, nevertheless, to the same area. After a varying period of such actions, the attitude of the male suddenly changes. Instead of pursuing the female, he is more subdued and takes to followering her about. He never allows her to escape from his sight, and as she hunts about near the water's surface, he vaunts himself on the nearest cat-tail. They now may be considered mated. At about this time (the last of April), although there are comparatively few birds in the marsh, the migration ceases for a time. The flocks which come in each night and leave each morning are scattering, and are composed entirely of resident birds. Before all of the birds have become mated, the females naturally predominate in the flights to and from the uplands, for the still unmated, resident males spend the entire day in the marsh. After mating occurs, and before and during the building of the nest and oviposition, the sexes leave together for the hills in the late morning, and return in the late afternoon. A study of the food at this season of the year, without reference to sex or time of day or place of collection, would therefore give most varied results. The vegetation in the marsh is beginning to show considerable green above the water. The cat-tails are about thirty inches in height, the burreed is well started, the water horsetail and the sweet flag are eight or ten inches in length, though not yet showing above the water's surface, and the sedges have sent up sprouts about two inches in length. Stretches of open water mark burned-over areas that will soon be covered with a new and luxuriant growth of sedges. Insects at this period appear in greater numbers and supply abundant food for the Redwings. Numerous tabanid and other dipterous larvæ are floating at the surface of the water, and furnish the almost exclusive food of some individuals. Other individuals continue their diet of lepidopterous larvæ and weevils, adding only the spiders, whose wind-blown webs sometimes fairly cover the cat-tails (Plate XVIII, fig. 3). But the migration has not yet ceased.

Arrival of resident immature males.—About the first week in May, after most of the adult resident birds have begun to nest, the immature residents begin to appear in numbers. The days are much longer now, and the sun does not sink below the hills until nearly seven o'clock. As a result, the migrating flocks do not appear in the marsh until much later in the evening. Between four and six P.M. the adult residents can be seen dropping in, usually singly or in pairs. Shortly after six, the first flock of migrants appears, frequently coming from the east, but more often from the south. Other flocks follow at intervals until nearly dusk. The flocks are small and rather irregular, the total number of individuals not exceeding seventy-five or a hundreed birds. From the second week in May until the last of the month, these flocks continue.

Arrival of resident immature females.—The immature females begin to appear with the immature males about the middle of the month. They increase in numbers until the first of June, when they far outnumber the males, and by the second week, when the last migrating birds are recorded, they compose the entire flocks. These flocks are nervous and erratic in their actions. They frequently appear during the middle of the day, flying over the marsh as though on a definite migration. The next moment, however, they swing back, scatter, settle down for a few moments, and just as suddenly are away again to another part of the marsh. It is doubtless through some of these birds, at a time when unattached males are difficult to find, that many of the cases of polygamy arise.

Summary of Spring Migration.—To summarize the spring migration, the groups of migrants and the period of migration are arranged below in tabular form. Inasmuch as definite dates have not been secured for a sufficient number of years to furnish averages, the period of 1911 only (with two exceptions, as noted) are employed.

I.	"Vagrants"	Feb. 25–March 4.
II.	Migrant adult males	March 13–April 21.
III.	Resident adult males	March 25–April 10.
IV.	Migrant females and immature males	March 29–April 24.
V.	Resident adult females	April 10–May 1.
VI.	Resident immature males	May 6–June 1 (1910).
VII.	Resident immature females	May 10–June 11 (1910).

The first date of the period of migration, as given above, is that of the first appearance; the last date in some cases is of necessity only approximate, because of the difficulty in distinguishing migrant from resident birds.

MATING AND SONG.

Summary of the Literature.—Concerning this phase of the life history but little has been written. Nuttall gives us the best account: "They continue to feed in small parties in swamps and by slow streams and ponds until the middle or close of April, when they begin to separate in pairs. Sometimes, however, they appear to be partly polygamous, like their cousins the Cow Troopials; as amidst a number of females engaged in incubation but few of the other sex appear associated with them; and as among the Bobolinks, sometimes two or three of the males may be seen in chase of an individual of the other sex, but without making any contest or show of jealous feud with each other, as a concubinage rather than any regular mating seems to prevail among the species." Baird, Brewer, and Ridgway (1874) tell us that "Late in April, they have all re-established themselves in their chosen haunts, have mated, and are preparing to make their nests. In Pennsylvania this is done in May, in New England early in June, and farther north a fortnight later." The observations of Peet (1908) in Michigan differ in some respects from those of the two preceding authors and from those made at Ithaca: "Upon arriving in the spring, the courting *begins at once*,* although nest building must be delayed for several weeks, as *no nests are built until the cat-tails are nearly grown*." * He then adds: "The females spend much of their time walking about among the dead, broken-down herbage, probably seeking food, but the males strut about on the limbs of the near-by trees, their feathers ruffled up and body swelled out. . . . During the time elapsing between their arrival from the south and nesting, the Redwings may usually be found scattered over the entire swamp, but with the coming of the breeding season, they collect in the clumps of cat-tails, where in a short time the nests will be built."

The song of the Redwing may well be discussed in connection with mating. Nuttall again gives us the most extended account: "They commence a general concert that may be heard for more than two miles. This music seems to be something betwixt chattering and warbling,—jingling liquid notes like those of the Bobolink, with their peculiar *kong-quĕr-rēē* and *bob ă le, o-bob ă lēē;* then complaining chirps, jars, and sounds like saw-filing, or the motion of a sign-board on its rusty hinge; the whole constituting a novel and sometimes grand chorus of discord and harmony, in which the performers seem in good earnest, and bristle up their feathers as if inclined at least to make up in quantity what their show of music may lack in quality. . . . Selecting their accustomed resort, they make the low meadows resound again with their notes, particularly in the morning and evening before retiring to or leaving the roost; previous to settling themselves for the night, and before parting in the day, they seem all to join in a general chorus of liquid warbling tones, which would be very agreeable but for the interruption of the plaints and jarring sounds with which it is blended. . . . Assembled again in their native marshes, the male perched upon the summit of some bush surrounded by water, in company with his mates, now sings out, at short intervals, his guttural *kong-quĕr-rēē*, sharply calls *t'tshéah*, or when disturbed, plaintively utters *'ttshāy;* to which his companions, not insensible to these odd attentions, now and then return a gratulatory cackle or reiterated chirp, like that of the native Meadow Lark. . . . If the nest is approached . . ., the female cries *'queàh, 'pueàh*, and at length, when the mischief they dreaded is accomplished, the louder notes give way to others which are more still, slow, and mournful; one of which resembles *t'ai', t'ai'*, or *téa* and *t'tsheàh.*"

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* The italics are the present writer's.

Bicknell (1882), in his studies of the singing of birds, states that their song always accompanies migratory movement, even as early as February 22. The chief song months are March, April, and May. After the middle of May, they lose their readiness of voice, but never cease singing before July, final songs being heard July 17, 28, and August 3. In the fall, singing is transiently renewed between October 14 and 17.

Baird, Brewer, and Ridgway (1874), in discussing the song, say: "The notes of this bird are very various and indescribable.

The most common one sounds like *con-cur-ee.* But there is also almost endless mingling of guttural, creaking, or clear utterances that defy description."

Townsend (1905), in listening to the voices of a New England marsh, found that on the 22d of May the Redwings ceased singing at 7.30 p.m. They did not sing during the night nor begin in the morning until between 3 and 3.15, after the Catbird, Song Sparrow, and Tree Swallow had begun to sing. Full dawn appeared at 3.45. At a later day (June 24) the Redwings were found to continue singing for about three-quarters of an hour after sundown.

To attempt to put in words what such men as Baird, Brewer, and Ridgway have considered indescribable, may appear somewhat rash. Nevertheless it would be advantageous to describe or classify, if possible, the various notes given, for they are not so infinite in number as might be supposed (at least not so at Ithaca). The greatest difficulty lies in the selection of words, letters, or symbols that will convey a sound similar to that uttered by the bird. The *con-cur-ee, kong-quer-ree,* or *gur-gel-lee* note, as it has been variously called, is sufficiently described to need no further remarks here. It represents the true song. It may be modified by the addition of various of the call notes to be next considered, but it is always recognizable. It is always accompanied by spreading of the wings and tail feathers and by erection of practically all the body feathers, especially those of the shoulder patches. It is given by the males alone, from first arrival until the middle of July, and again, to some extent, in the fall. In addition to this song, there is another, restricted to the males which is heard occasionally on cold days of spring, especially by the first "vagrants" to arrive. These birds seldom give the *kong-quer-ee* note, but indulge in a low monotone chuckle, which is difficult of description. A large flock engaged in this monotone can be heard for a considerable distance.

The call notes can be put into two groups, the *check* notes and the whistles. Of the former there are two which are easily recognized. The first is the flight note, which may be represented by the word *chuck.* This is the note which first attracts our attention to a flock flying over. The second is a scolding note, which is, in general, similar but much shorter in its accent. It may be represented by the word *check.* The latter note is given whenever one intrudes upon the bird's haunts.

The whistles, likewise, are of two sorts, dependent upon the inflection. The first, with a falling inflection, is rather plaintive, and not so scolding as the second. It is probably what Nuttall represented by *'ttshāy.* The second does not have the falling inflection, and begins more abruptly than it ends. It is probably the note which Nuttall describes as *t'tshéah.* This is the alarm note; it is given when the nest is approached, and arouses all of the other birds within hearing. Various combinations of these call notes, with slight modifications, are frequently given, but they can almost always be resolved into these factors. For example, a sort of scolding song, which is given in the air, with quivering wings, can easily be resolved into: *check, check, check, t'tshéah.* A modification of this, which is given by both birds at the breeding season, but especially by the female, substitutes the *chuck* note for the *check,* and a *chee* note for the whistle, and may be represented thus: *chuck, chuck, chuck, chee-e, chee-e, chee-e.*

Although song begins with the arrival of the first true migrants, mating can not take place for several weeks. The first migrating females do not arouse the males, and travel unmolested. After about a week, however, the males begin to notice them, and song and display are augmented. Upon the arrival of the first resident females, the reproductive organs of the males become considerably enlarged (Plate XXI, *F*), and song and display reach their height. In addition to the ordinary display and erection of feathers, a method of soaring is now indulged in. In comparison with that of the Lark, it is rather crude, but undoubtedly it is akin to it. Mounting by a rather irregular spiral, the male bird attains a considerable height, where he hovers, oftentimes for long periods, while his wings barely flutter. Song is not generally indulged in. Eventually, with half-closed wings, the bird drops down in a zigzag course to the marsh. A dozen or more birds may frequently be seen in the air at once, as they perform these evolutions. At this time, also, hovering at a much lower height is frequently indulged in. With a few quick strokes of his wings, the male vaults from his post into the air, and with quivering wings and flaming shoulders, gives vent to his pent-up passion in the "scolding song" described above. After mating has taken place and family cares have begun, song gradually diminishes, although it is still frequently heard from some individuals until late in July.

As before stated, the arrival of the first resident females arouses the males to a sort of frenzy, and whenever one appears in sight, it is pursued and driven from the neighborhood. A migrating female immediately leaves the vicinity, but a resident bird returns to the same spot. With a few birds mating occurs at once, so that the first nests are started by the beginning of the third week of April. Normally, however, the male continues to drive away the female for a week or more after her first appearance. But she clings to the spot, and eventually his attitude changes. Instead of pursuing her, he follows her around while she feeds about the debris upon the water. Actual mating may not occur, however, for a week or two after the female has made her choice of a future mate. Meanwhile she spends the middle of the day on the uplands, while the male remains in the marsh. After mating and before nest-building, she spends the entire day in the marsh and only occasionally leaves, accompanied by her mate. After the nest is commened and through the egg-laying period, both birds ordinarily spend the middle of the day on the uplands; particularly is this true of those nesting during the earlier part of the season.

Nuttall states that "a concubinage rather than any regular mating seems to prevail among the species," and there is very good ground for the belief, although there seems to be a great deal of individual variation in this respect. Certain pairs have been observed throughout the season, and found to be mated as steadfastly as are most birds, while in others the tie seems to bind only so long as the male is watchful and able to exert his lordship in driving away other males. A female has been observed to receive one male with spreading wings and quivering feathers, and the next moment, when this bird had been driven off, to welcome the victor with the same freedom and display. To what extent this prevails, it is, of course, difficult to say. Cases of polygamy, such as Nuttall suggests, probably occur even more frequently than polyandry. Coues (1883) reports on two such cases observed by Beal in the prairie sloughs of Iowa, and many other cases doubtless have been noted. In a large marsh, where a great many birds are nesting, it is difficult to decide with precision in such cases, since the slightest disturbance brings males from all parts. One definite case, however, was observed during 1910, where a male mated with two females. The nest of the first female and her relations with the male were perfectly normal. The nest of the second female was built about five days later than that of the first, and at a distance of about 25 feet. Three eggs were laid, but one of them disappeared and another proved infertile. This nest was rather poorly constructed, and it slipped down on one side. The relations of the second female with the male were not extremely close, the only interest usually shown by him being that of driving other males from the neighborhood of the nest. She had, however, no other mate. The two nests were watched for many hours at a time from a blind.

After the choice of mates, an interval of a week or more may intervene before the building of the nest, although it is frequently less, and in many cases the nest is started immediately. By the end of the first week in May, most of the adult birds are mated and have started to build. When mating occurs, the ovaries of the females are far from mature. The organs of the male, on the other hand, have reached nearly a maximum of development. (Plate XXI, *R* and *H*.)

NESTING.

To quote from every author who has written on the nesting of the Redwing would be an endless task, and would result in much unnecessary repetition. Nuttall has written the most complete account, and is quoted almost in full below. Only such parts as add materially to this account will be selected from other authors.

"About the end of April or early in May, in the middle and northern parts of the Union, the Red-winged Blackbirds commence constructing their nests. The situation made choice of is generally in some marsh, swamp, or wet meadow, abounding with alder (*Alnus*) or button-bushes (*Cephalanthus*); in these, commonly at the height of five to seven feet from the ground, or sometimes in a detached bush or tussock of rank grass in the meadow, the nest is formed. Outwardly it is composed of a considerable quantity of the long, dry leaves of sedge-grass (*Carex*), or other kinds, collected in wet situations, and occasionally the slender leaves of the flag (*Iris*) carried round all the adjoining twigs of the bush by way of support or suspension, and sometimes blended with strips of the lint of the swamp *Asclepias*, or silkweed (*Asclepias incarnata*). The whole of this exterior structure is also twisted in and out, and carried in loops from one side of the nest to the other, pretty much in the manner of the Orioles, but made of less flexible and handsome materials. The large interstices that remain, as well as the bottom, are then filled in with rotten wood, marsh-grass roots, fibrous peat, or mud, so as to form, when dry, a stout and substantial, though concealed shell, the whole very well lined with fine, dry stalks of grass or with slender rushes (*Scirpi*). When the nest is in a tussock, it is also tied to the adjoining stalks of herbage; but when on the ground this precaution of fixity is laid aside. . . . They raise two broods commonly in the season. . . . When the young are taken or destroyed, the pair continue restless and dejected for several days; but from force of their gregarious habit they again commence building, usually soon after, in the same meadow or swamp with their neighbors."

Wilson's account, while quite full, contains no information not conveyed by Nuttall. Samuels (1887), Stearns (1881), Goss (1883), and Capen (1886) each give a more or less extended account of the nesting habits, but add nothing to Nuttall's description. Capen does not record the first set of eggs until the last of May. Merrill (1888) found half-grown young at Fort Klamath, Oregon, on May 27, which would mean that the set of eggs was completed about May 12. Chapman (1888) records a nest containing four eggs at Gainesville, Florida, on May 6. Dugmore (1902) states that "The nest varies greatly in its construction and situation; usually of weeds and coarse grasses, lined with *hair**. . . . Most nests are about three inches deep inside, but some that are built like the orchard oriole's are much deeper." Baird, Brewer, and Ridgway (1874) state that "Mr. Maynard found these nests placed in trees twenty feet from the ground. One nest was built on a slender sapling at the distance of fourteen feet from the ground. The nest was pensile, like that of the Baltimore Oriole. It was woven of bleached eel-grass." Further on appears the statement: "So tenacious are they of a selected locality, that I have known the same pair to build three nests within as many weeks in the same bush, after having been robbed twice. . . . In New England these birds have but *one** brood in a season. Farther south they are said to have three or more." Stockard (1905) gives the limiting dates for nests as May 12 and June 27 in Mississippi, with the height of the breeding time at about June 1. He also records "eleven nests of the Redwing . . . found in a peach orchard which was located one mile from the Mississippi River, but the ground was dry and not at all marshy." Brewster (1905) also records a nest in a vertical fork of a small apple tree. Judd (1907) does not record the Redwing as nesting "until the latter part of May or early in June" in Albany county, N. Y. Peet (1908, Michigan) records the earliest nests with completed sets of eggs on May 9. He states that "Two or three broods are usually raised," and that "Sometimes as many as a dozen nests are found within a space ten feet [!] square." He writes that they "continue nesting through June," but it is quite obvious that the time between May 9 and July 1 is too short for three broods. Cleaves (1910) records a group of Redwings nesting in a daisy field after the destruction of their former breeding ground in a near-by marsh.

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* The italics are the present writer's.

To summarize, in so far as the conflicting statements will admit, it has been stated that the Redwings begin building about the second week in May in the Middle and Northern States, and one or two weeks earlier farther south. They rear one, two, or three broods a season, depending upon the locality. The nest shows a great deal of variation in structure, materials used, and location, but a normal nest is composed of three parts: an outer basket woven into the supporting bushes or rushes, a filling of mud or decayed wood, and a lining of finer materials. The Redwing shows great adaptability with regard to nest construction, and a tenacity for a selected nesting site despite great changes in the environment or disasters which may befall its nest.

At Ithaca nest-building commences about the middle of April, but it is not until the first part of the second week in May that all of the adult males are mated and have nests started. At this time, it will be recalled, the immature resident males are just beginning to arrive, so that before they are mated and nesting, it is the last of May. Thus the height of the nesting season is reached about the first of June. The adult birds commence building again, often before the first young have left the nest. The second nest is located in the immediate vicinity of the first, frequently within a distance of ten feet. This is true also when the first nest has been robbed or destroyed. One pair, which was experimented upon, built four nests within a radius of twenty-five feet between April 15 and May 18. The first nest was deserted before completion, probably because it was discovered, and the second was immediately started about fifteen feet to the east. This was completed in six days, and a complement of three eggs was then deposited. This nest was removed on April 26. Another was soon finished about fifteen feet to the south, the complement of eggs again numbering three. This was removed on May 6. The fourth nest, which was built about ten feet to the south of the third, likewise contained three eggs when the full set had been deposited. This nest was removed on May 18. A fifth nest was doubtless constructed, for two weeks later both birds were seen still clinging to the spot. On account of the presence of other nests in the vicinity, however, it was not identified with certainty. A comparison of the three completed nests shows them quite similar in construction and in materials used. The first two are more regular in shape, however, since the third was built entirely in the growing vegetation and had to be adapted to it.

A comparison of the eggs shows a relatively normal amount of variation as to color and markings, the last set having a slightly darker ground color and heavier spots. The size shows a gradual increase from the first to the last eggs laid, as the following table of measurements shows:

Date taken.	Length.	Width.
Apr. 26, 1911	23.0 mm.	17.0 mm.
Apr. 26, 1911	23.2	17.0
Apr. 26, 1911	24.2	18.0
May 6, 1911	24.2	18.0
May 6, 1911	25.4	18.0
May 6, 1911	27.0	19.0
May 18, 1911	27.2	18.2
May 18, 1911	27.2	18.4
May 18, 1911	28.0	19.0

The first nests built are located in the dead stubs of the cattails that have been burned over during the previous fall. At first they are not sheltered by vegetation of any kind, for the new growth is barely above the water (Plate IX, fig. 1). Occasionally nests are located in the tangles where the flags have not been burned. As the season advances and the vegetation grows, green stalks are included in the support. At first these are not sufficiently strong to serve alone as a support, and consequently the nests are always attached on one side to a dead stub (Plate IX, fig. 2). This is true of most of the nests constructed in early May, and it generally results in disaster. So firmly are the nests fastened by the strands of milkweed fiber, that the side attached to the green blades is carried upward by their growth, while the other, attached to the dead stubs, remains fixed. As a result, the one side is lifted at the rate of almost an inch a day until the nest is inverted (Plate XVII, fig. 1). The birds continue to incubate until the last egg is rolled out. Later, as the growing cat-

PLATE IX.

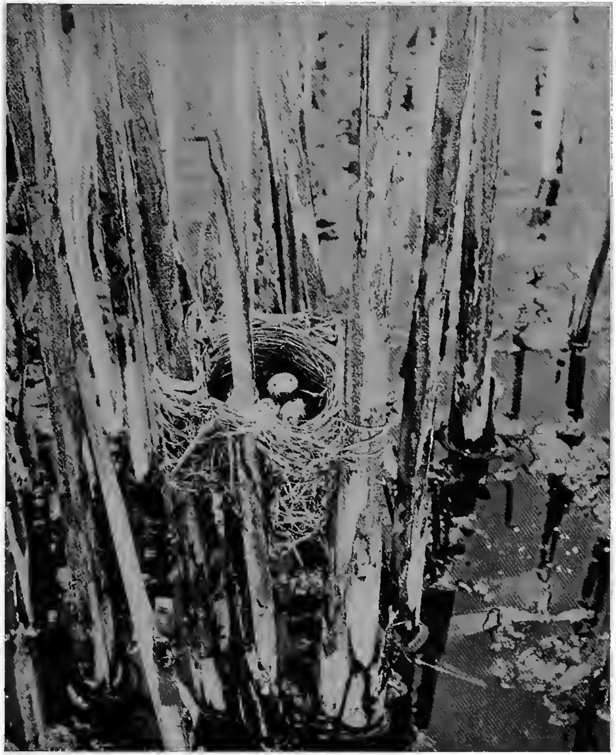


Fig. 1.—Nest built during late April, between the dead cat-tail stubs.

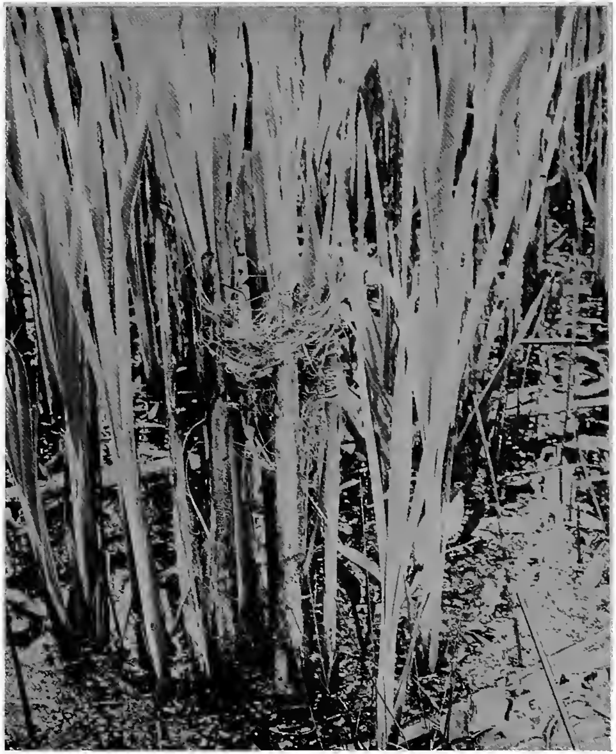


Fig. 2.—Nest built during early May, between dead stubs and growing vegetation.

PLATE X.

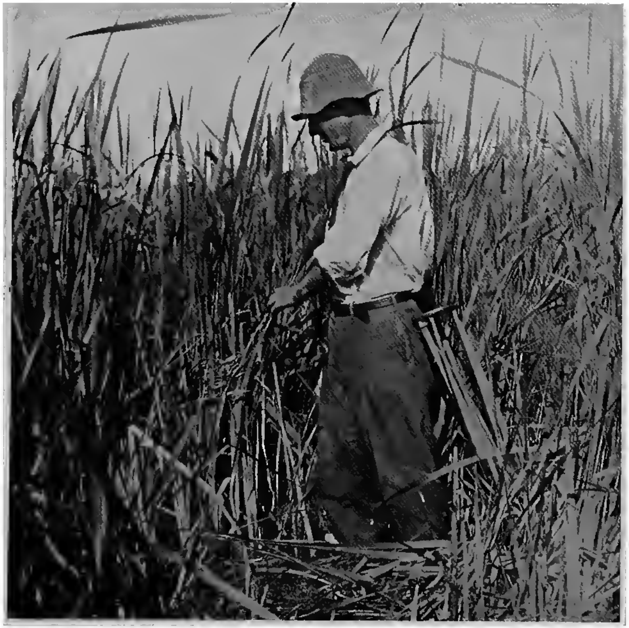


Fig. 1.—Nest built in the cat-tails during late May, showing the altitude above the water

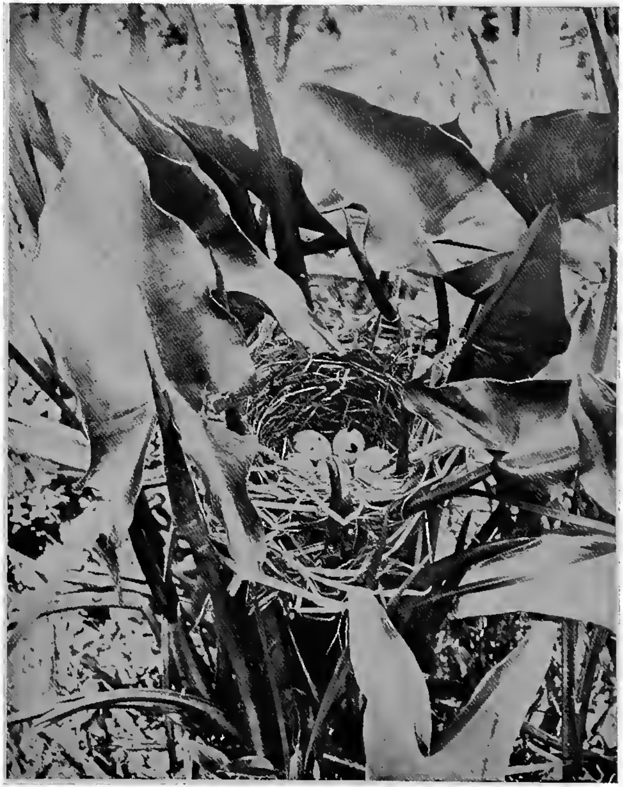


Fig. 2.—Nest in arrow arum in early June.

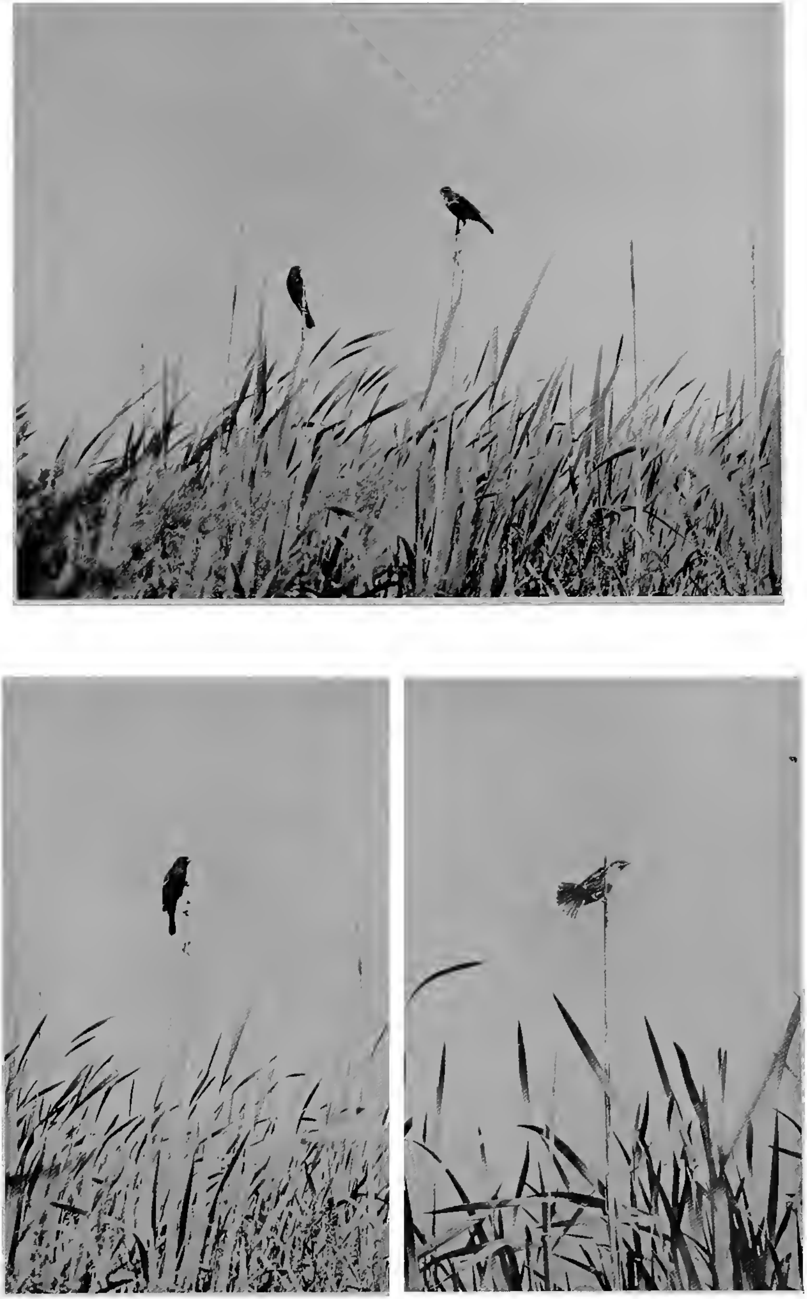
tails become stronger and denser, suitable nesting sites can be found without the employment of the stub supports, and many of the nests are suspended freely in the growing vegetation. These nests are seldom capsized, though frequently the growth of the vegetation squeezes the nest together, crowding the young until they are forced to leave prematurely (Plate XVII, fig. 2). By the end of the third week in May, most of the vegetation in the marsh is sufficiently strong to support a nest, and as a result, nests built at this season are located rather indiscriminately in cat-tail, sedge, burreed, water horsetail, dock, or arrow arum (Plate X, fig. 2). By the first of June the cat-tails and sedges are matured, and have become very dense and harsh. The Redwings now desert them for the softer vegetation, such as the dock and smartweed, which by this time fill most of the small ponds. A few pairs, however, continue to nest in the cat-tails about the edges of ponds, where it is unnecessary for them to penetrate at each visit the harsh, dense tops of the vegetation above the nest. With the change in nesting site during the season, there is a corresponding change in the altitude of the nest above the water. Beginning in the middle of April, the nests are located at an average of eight or ten inches above the water, but by the middle of June the average has risen to twenty-five inches (Plate X, fig. 1). This is doubtless due to the elevation, with the growth of the vegetation, of the available nesting sites. There is likewise a corresponding change in nesting material and workmanship. The first nests, constructed by adult birds with plenty of time and material, are very neat, compact structures, like that described by Nuttall. Later nests, however, built by immature birds when the supply of milkweed fiber has been greatly depleted and time is more limited, are much less complete, not infrequently with one of the three main parts eliminated. The nest shown in Plates XIV–XVI is such a one, composed almost entirely of narrow strips of cat-tail and sedge, without the feltlike filling and much of the grass lining. In general, the materials are those which are most convenient at the season and spot in which the nest is being constructed, and they are utilized in so far as they can be adapted to the type of nest to which the Redwings strictly adhere. Thus, the outer basket may be composed entirely of fibers of milkweed, or of grasses, or of strips of sedge. The sedge, however, to be as flexible as the fiber and as adaptable to the necessary weaving, must be wet. Hence, when such material is used, it is always taken from the water and used in a moist condition. The "felting" of the nest may be dead wood, decaying fragments of *Typha*, or mud. The exact kind of material is not as important as its general nature.

The time required for building a complete nest is usually six days. Of this time, three days are spent on the outer basket and "felting," and three days on the lining. Many of the later, more poorly built nests require much less time for construction, some of them being completed in as few as three days. The materials, as might be judged from their nature, are frequently gathered from very different parts of the marsh; the outer and lining layers generally come from the margins, and the "felting" from the open marsh in the immediate vicinity of the nest.

The attachment for the chosen nesting site, which is shown from the first arrival of the male bird, and which causes a pair to nest time and again about the same spot when the nests are destroyed, is equaled only by their sensitiveness to the discovery of the nest before its completion. If a nest is discovered before the deposition of the first egg, it is usually deserted. Practically every nest constructed before the second week in May, and discovered before its completion, has been deserted. Generally the birds build a second nest a short distance away, employing more or less the materials from the first nest. Very frequently the cause for desertion has been no more than a person's walking past the nest at a short distance, and the bending of a flag to mark the spot. Later in the season, especially in the case of the immature birds, this sensitiveness is not so marked.

The construction of the nest, in all cases observed at Ithaca, has been entirely by the female. The male has never been seen with nesting material in his bill. He is very attentive, however, during the process. This usually takes place

PLATE XI.



REDWINGS NEAR THE NESTING SITE ILLUSTRATING THEIR METHOD OF PERCHING ON THE VERTICAL CAT-TAILS.

only during the early morning and late afternoon, both birds leaving the marsh during the heat of the day. When long excursions are made to the edges of the marsh, the male accompanies the female. When she forages near the nest, he takes a position upon some prominent point, from which he can keep her under his eye and drive away any intruding males. Such watchfulness may have resulted from the female's tendency toward polyandry, which has been mentioned above.

Egg-laying usually follows immediately upon the completion of the nest, though intervals of two and three days before the deposition of the first egg have been recorded. The usual complement is three or four, the one number being as common as the other. Not infrequently five eggs, and rarely six, are found in a nest. Sets of seven, as recorded by Dawson (1903), have not been discovered here. The eggs are always unmistakable, though there is considerable variation in color, markings, size, and shape. Baird, Brewer, and Ridgway's (1874) concise account of the eggs may be quoted here: "The eggs vary greatly in size: the largest measures 1.08 inches by .82 of an inch; the smallest .90 by .65. They average about an inch in length and .77 of an inch in breadth. They are oval in shape, have a light bluish ground, and are marbled, lined, and blotched with markings of light and dark purple and black. These markings are almost wholly about the larger end, and are very varying." One nest was discovered containing four eggs, which were slightly paler in ground color than the average, and had no spots or markings of any kind. From these to eggs in which the ground color is almost concealed with cloudings of brown, and with heavy spots and blotches, all intergradations have been found.

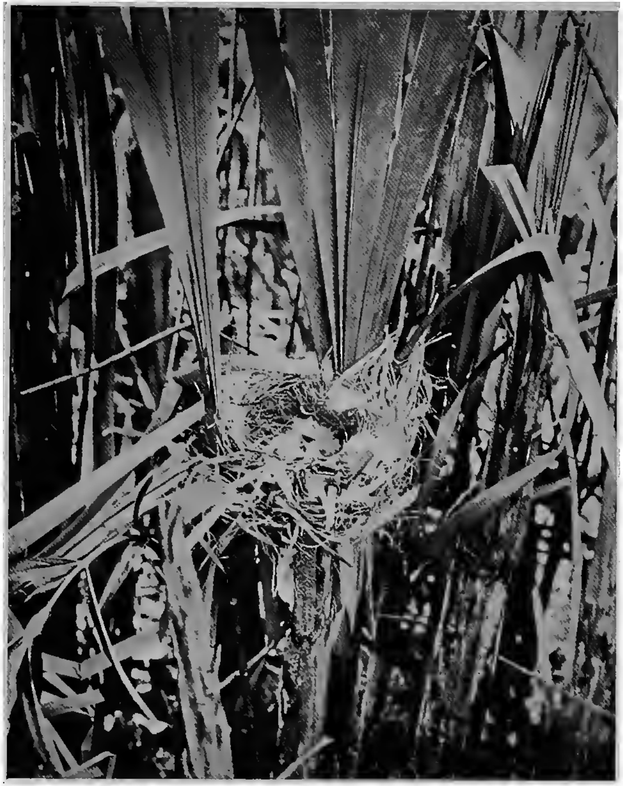
During the days when the eggs are being deposited, frequently both birds continue their excursions to the uplands, With the laying of the third egg, incubation begins, and thenceforth both birds remain in the marsh. Incubation, so far as observed, is performed entirely by the female. In one instance the first egg hatched in ten days, and frequently one or more of the eggs requires twelve, but the usual period is eleven days.

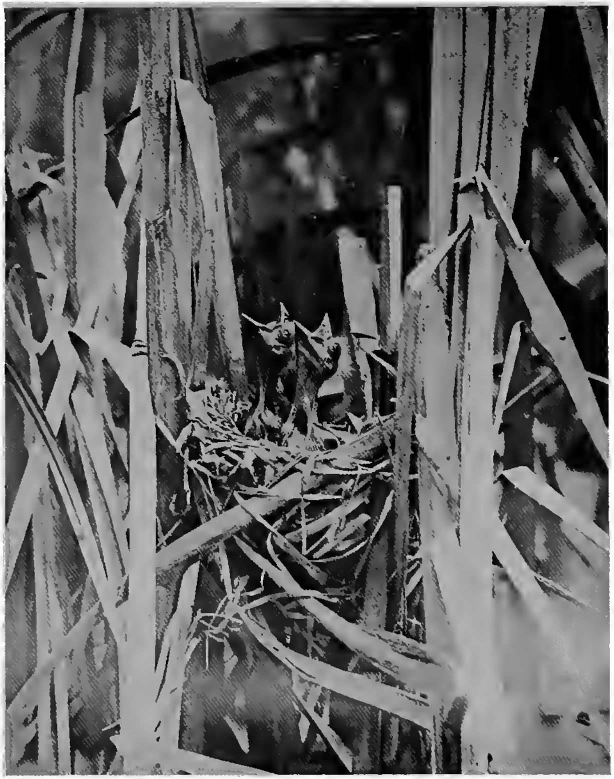
THE YOUNG.

Concerning the development and care of the young, but little has been written. Herrick (1901) gives the most complete account. He writes as follows: "On the fifth day of July a nest of three young Blackbirds, . . . aged five days, was found. . . . On . . . July 11th, . . at about half-past eleven o'clock one of the fledglings left the nest and was fed by the old birds in the surrounding bushes of the marsh. . . . Three days later the swamp was visited at just after sundown, when the young birds suddenly arose from the nest and flew off with ease and precision." Evidently the first bird was in the nest eleven days, and the others fourteen, provided they were five days old when first found. A summary of the observations made on the development of the young at Ithaca, for various nests in 1910, is as follows:

At *hatching* the young are blind and helpless. The skin is scarlet, with but a scant covering of buffy or grayish down along the principal feather tracts (Plate XII, fig. 1). They are at first exceedingly helpless, scarcely able to raise their heads for food, but they gain strength rapidly after the first feeding. During the *first* day there is considerable increase in size. On the *second* day feather sheaths of the primaries and secondaries show distinctly. By the *third* day these feather sheaths appear distinctly along all of the tracts. On the *fourth* and *fifth* days there is a great increase in the size of the body and in the length of the quills (Plate XII, fig. 2). On the *sixth* the feather sheaths of the wing break open. On the *seventh* the wing feathers have grown considerably, and those of the other tracts begin to break. On the *eighth* all of the sheaths have broken, and the wing feathers have attained considerable length. On the *ninth* the feathers have grown still further, but do not yet cover all of the bare spaces (Plate XIII, fig. 1). The young can fly short distances, however, and can not be kept in the nest if once frightened or removed. If the nest has become polluted, as frequently occurs when it has become greatly compressed by the growing vegetation, they may leave of their own accord on this day. On the *tenth* the stronger of the young leave and climb to near-by

PLATE XII.





DEVELOPMENT OF THE YOUNG OF THE REDWING.

FIG. 1.—JUST HATCHED.

FIG. 2.—FIVE DAYS OLD.

PLATE XIII.

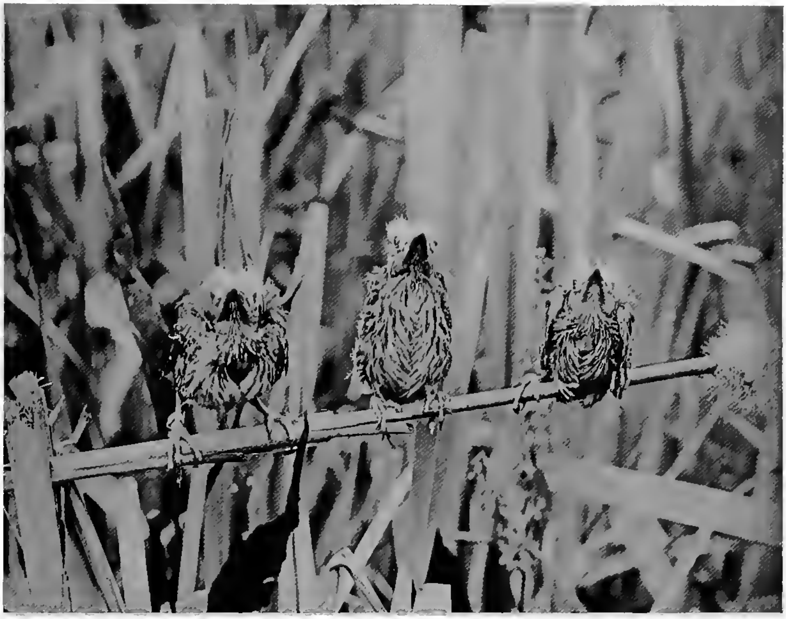


FIG. 1.—NINE DAYS OLD.

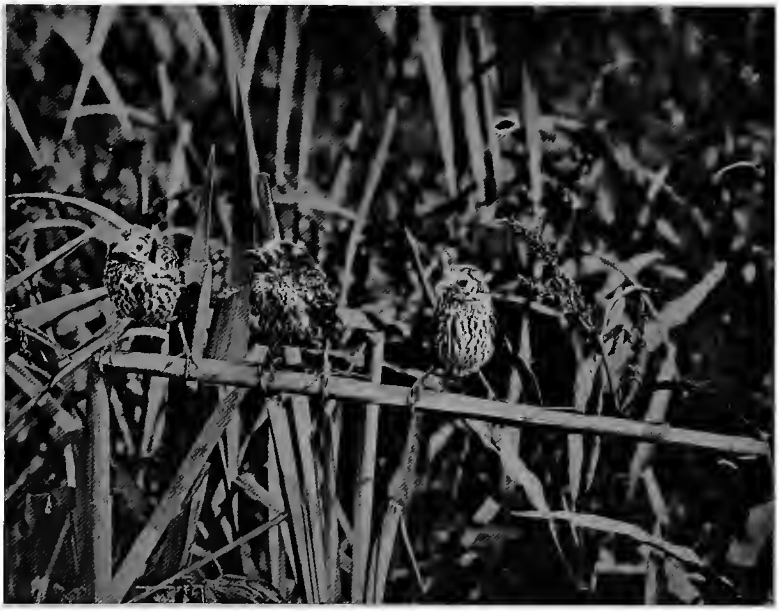


FIG. 2.—TEN DAYS OLD.

DEVELOPMENT OF THE YOUNG OF THE REDWING.

supports (Plate XIII, fig. 2). If the nest is approached, all leave, but otherwise the weaker remain until the *eleventh* day (Plate XIV, fig. 1), when all scatter to the vegetation in the immediate vicinity. They then remain in this neighborhood for at least ten days, even after the parents have ceased caring for them and have started a second brood.

Herrick also gives us the following information concerning the care of the young: "In the space of four hours on the first day. . . fifty-four visits were made and the young were fed forty times. The female brooded her young over an hour, fed them twenty-nine times, and cleaned the nest thirteen times. The male made eleven visits, attending to sanitary matters but twice. . . . On the following day, . . . in the course of nearly three and one-half hours, fifty-five visits were made, and the young were fed collectively or singly forty-three times. . . . The male bird served food eleven times and attended to sanitary matters once. In the course of forty-two minutes the first young bird to leave the nest was fed eight times, seven times by the mother and once by the father."

Observations on the care of the young in this study are yet incomplete. Just as all of the work of incubation is performed by the female, so the care of the nest and young rests largely with this sex. Although the male always shows great concern when the nest is approached, he has seldom been seen to assist in the actual care of the young. (There is evidently considerable individual variation in this respect.) Previous to the hatching of the eggs, the male is more bold in the presence of danger, but after hatching the instinct becomes much more pronounced in the female.

The food of the young consists entirely of animal matter, so far as observed here, although Judd (1900) found one per cent of weed seeds in the food of nestlings examined by him. It does not vary materially with the age of the young, but more especially with the insects predominant in the marsh and therefore most easily secured at the time. The principal insects eaten are May flies, caddis flies, and lepidopterous larvæ. Generally three or four insects are brought each time, and one delivered to each young. This is not always the case, however, for sometimes the entire mass is given to one bird. There seems to be no order in this distribution, the young bird with the longest neck and widest mouth always getting fed first. The food is delivered well down into the throat of the young (Plate XV, fig. 1), and if not immediately swallowed is removed and given to another. The number of visits or periods of feeding varies with different individuals, and in general increases with the age of the young. Two different nests were observed with young of about the same age (four days). One female made visits about once a minute, but took long rests every ten minutes or so; the other was more regular, but her visits averaged only once in five minutes. After almost every feeding, the nests were scrupulously cleaned, and the excrement, enclosed in its membrane, was carried some distance from the nest before it was dropped. Some individuals drop the excreta always in the same spot.

FALL MIGRATION.

With the gathering together of the Redwings in the fall and their visitations in vast flocks upon the grain fields, they are so conspicuous and are of such economic importance that they have received a great deal of attention, both by ornithologists and by the public at large. Wilson (1831) writes that toward the middle of August the young birds begin to fly in flocks chiefly by themselves. He tells of their feeding on green corn in September and of the method employed to destroy them on their roosts by setting fire to the marsh. He states that about the first of November they begin to move off toward the south, though near the seacoast, in New Jersey and Delaware, they continue long after that period. Nuttall's account is very similar to that of Wilson, but goes a little more into detail: "In the latter part of July and August the young birds, now resembling the female, begin to fly in flocks and release themselves partly from dependence on their parents, whose cares up to this time are faithful and unremitting; a few males only seem inclined to stay and direct their motions. About the beginning of September these flocks, by their formidable numbers, do great damage to the unripe corn, which is now a

PLATE XIV.

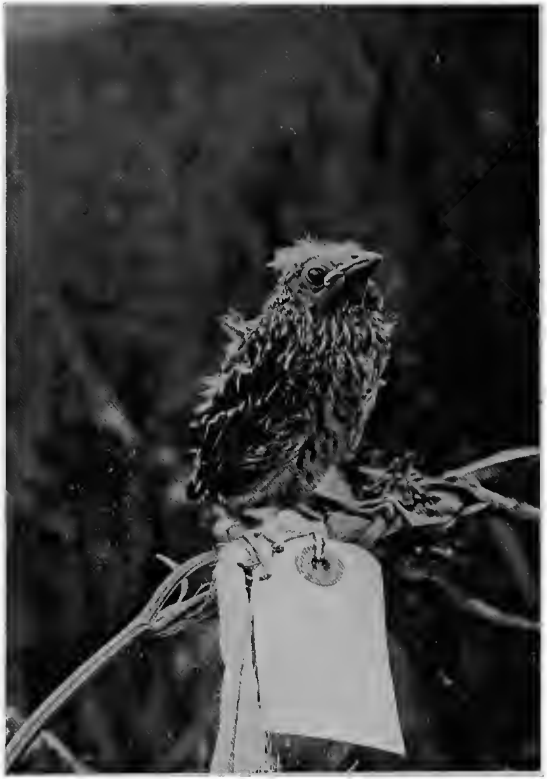


Fig. 1.—Young Redwing, eleven days old.

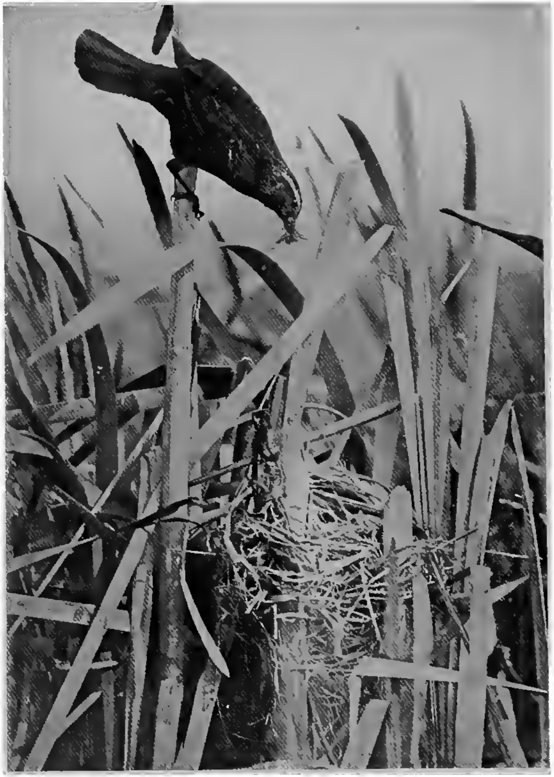


Fig. 2.—Female Redwing approaching the nest.

PLATE XV.

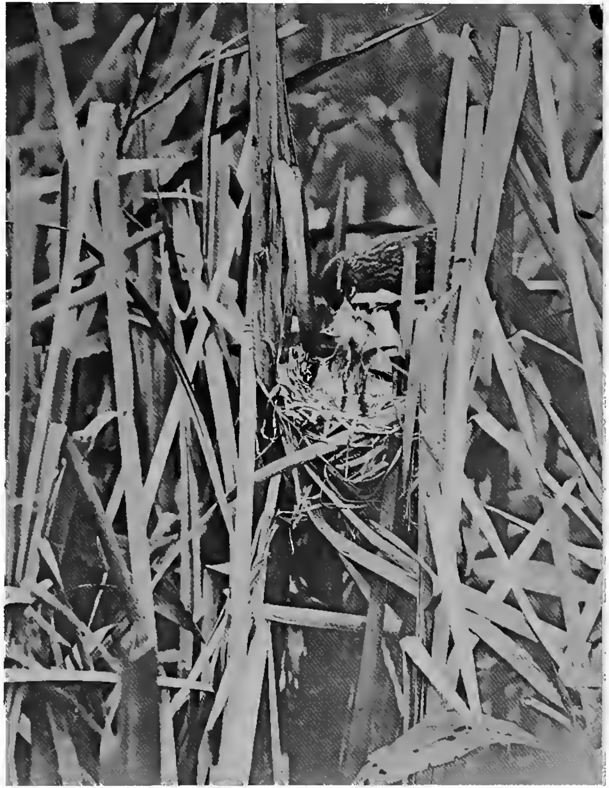


Fig. 1.—Female Redwing delivering the food.

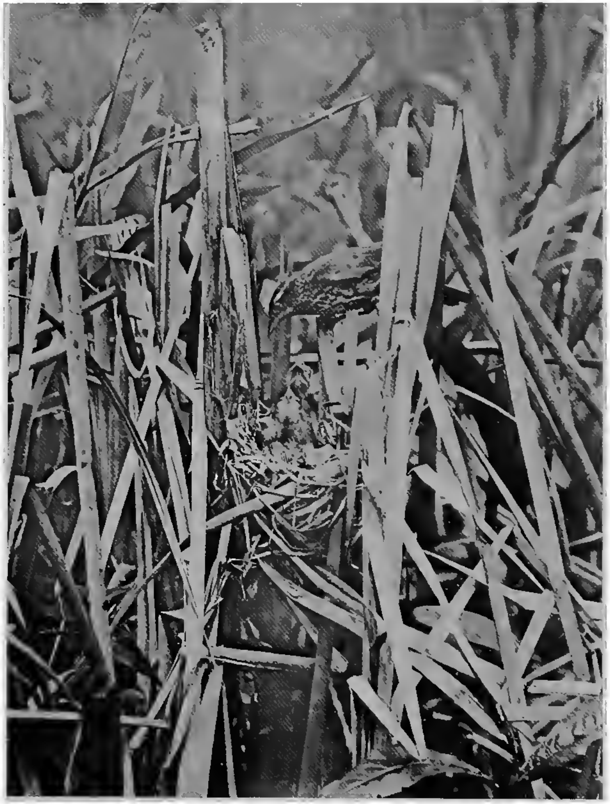


Fig. 2.—Inspection after feeding.

PLATE XVI.

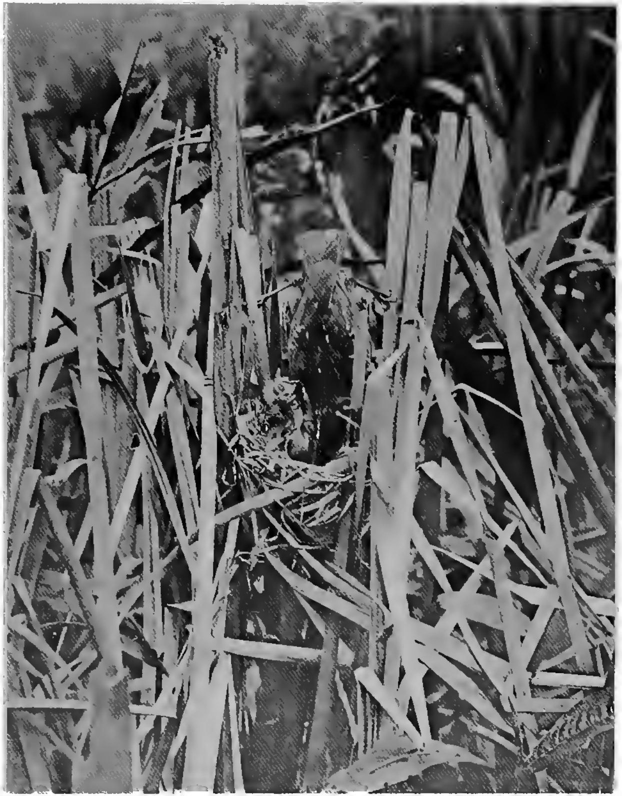


FIG. 1.—SEARCHING THE NEST FOR EXCREMENT.

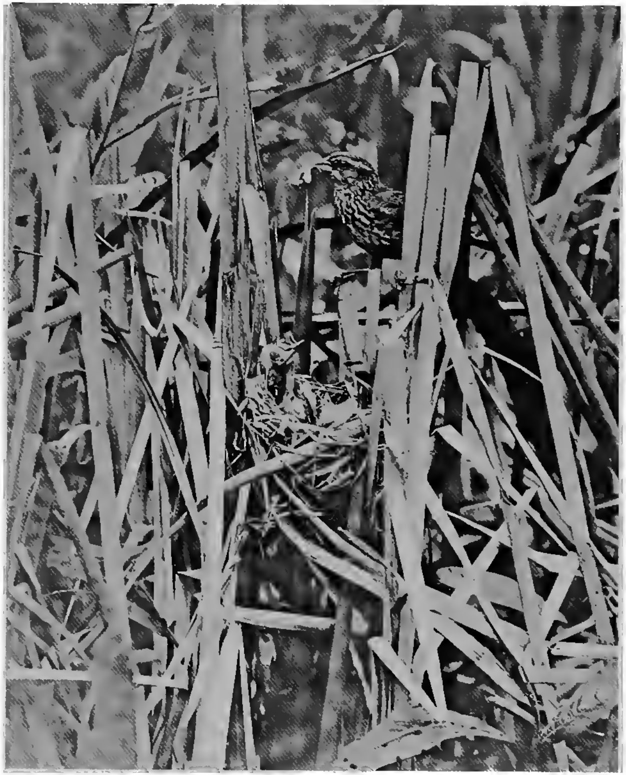


FIG. 2.—CARRYING AWAY THE EXCREMENT.

favorite repast; . . . . towards the close of September . . . they begin to roost in the reeds, whither they repair in large flocks every evening from all the neighboring quarters of the country; upon these they perch or cling, so as to obtain a support above the surrounding waters of the marsh. . . . Early in November they generally leave the Northern and colder States, with the exception of straggling parties, who still continue to glean subsistence, in the shelter of the seacoast." Samuels (1867) states that "Two broods are usually reared in the season: as soon as the last brood leaves the nest, the whole family joins with its neighbors into a flock of sometimes a hundred or hundred and fifty or more," and "about the last of October, they depart on their southern migration." In 1885 Bicknell noted the disappearance of the Redwings during a period of the fall, stating that the adult males disappear about the end of July, while the females and young remain abundant and congregate in mowed meadows. In September, the females and young likewise disappear, in some years almost altogether. He offers no explanation for this disappearance. Lloyd (1887) states that in Tom Green and Concho Counties, Texas, the Redwings winter, the males keeping in separate flocks with the young males, only a few of the latter being found with the females. Lawrence (1889) records that on New York Island "the first birds flying south were the Red-winged Blackbirds (*Agelaius phœniceus*); from the middle of July, for some weeks, there would be a flight of this species every afternoon, coming in flocks of from twenty-five to fifty or more individuals." The disappearance of the Redwings during a period of the fall is again noted by Coombs (1892) in Louisiana. "About the middle of August this species, as also the Great-tailed Grackle, becomes temporarily scarce, presumably leaving for the better feeding grounds of the rice districts further northward. Returning later, much swelled in numbers, they continue abundant until about April first, when the departure of migrants thins the ranks appreciably." Loomis (1892) likewise notices this disappearance during the fall: "The gathering of clans of Red-winged Blackbirds and their subsequent disappearance form one of the closing features of the month (July). . . . The opening fortnight (November) witnesses the full tide of Blackbirds, the Red-winged returning after a long void but imperfectly broken since the breeding season." Between 1892 and 1905 various references to the fall migration are made, but nothing new is added. In 1905 Townsend gives an account of the fall migration as it occurs in Essex County, Mass. "As early as July 1 the females and young gather in small scattered flocks, together with a few adult males. By the middle of July the flocks are moderate in size, while by the end of the month they have gone up into the hundreds, composed of females and young, while only a few red-shouldered males are to be seen. . . . The flocks of young then diminish in size and by the end of August are generally gone. Then ensues a period when Red-winged Blackbirds are rarely seen, but in the latter part of September and in October large flocks of the more northern birds appear."

To summarize, then, it has been stated that after the second brood has left the nest, which may be as early as July 1, the females and young gather in flocks and visit the uplands. The males assemble in similar places, but remain in distinct flocks. Here they feed largely in grain and stubble fields. During the first of August all of the Redwings disappear, and are not seen again until the middle or latter part of September. The males are the first to disappear. This phenomenon has been noticed from Massachusetts to Louisiana, and has been variously interpreted. In the north it has been explained as their departure for the south, and in the south as a departure for better feeding grounds. During the last of September they appear again in numbers larger than ever before, the sexes in distinct flocks. At this time they come to the marshes to roost each night, and feed on the uplands during the day. During the winter they may be found in the states south of Maryland in large flocks. The sexes remain apart, but generally a few immature males accompany the females.

Considerable time has been devoted to the study of the postnuptial movements of the Redwings at Ithaca, until it is believed that an understanding has been gained of the "mysterious disappearance" and the phenomena of the migration. It has been previously stated that the young remain in the vicinity of the nesting site frequently for ten days after the cessation of care by the parents. They then make their way to the borders of the marsh, where they are joined by other young until considerable flocks are formed. With them a very few adults of either sex are usually associated. They spend the day gleaning food about the alder-willow and grass zones, but generally spend the night in the open marsh. Their food is still largely animal, consisting primarily of weevils and lepidopterous larvæ. By the first of July, small flocks begin leaving the marsh in the morning to seek their food on the uplands. They join the numerous Grackles and Cowbirds which are now through breeding, and together they visit grain and stubble fields, where they frequently do considerable damage by reason of their large numbers. Their diet now changes from the insectivorous marsh type to an almost strictly herbivorous diet of grain and weed seeds. By the first of August the breeding season is entirely over, and they are joined by the females and the young of the second brood, while the males congregate in flocks by themselves. For several weeks now, no Redwings are found in the marsh during the day, but may be seen coming in at sundown and leaving at dawn in considerable flocks. But the molting season has commenced. The inner primaries and many of the body feathers have already been replaced. The "mysterious disappearance" now begins to take place. The adult males, which begin molting about two weeks earlier than the females or young, are the first to go, and shortly they are followed by the females and young. To the ordinary observer they have completely disappeared. No longer are they seen leaving the marsh in the morning or returning at evening. Along the ponds, streams, and lake shore there are none to be seen. They are apparently gone from the neighborhood. If at this time, however, one penetrates into the heart of the marsh, where the flags wave four and five feet over his head, he may hear a rush of wings ahead of him as a flock of birds breaks from cover and drops again into the flags a short distance beyond. He may hear this again and again, and yet never see a bird, so impenetrable is the thicket of flags. A few vigorous "squeaks," however, such as frequently draw birds from cover, and the secret is disclosed. A flock of tailless, short-winged birds hovers above his head for a moment, and then is off again into the tangle. If specimens are collected, the disappearance of the Redwings becomes no longer mysterious. Aside from the loss of the tail, which is obvious, one finds that the outer primary feathers are but just breaking their sheaths. With such handicaps, it is no wonder that the long flights to the uplands are not attempted, and that they seek protection in the effectual shelter of the marsh. The fall disappearance, then, corresponds to that period of the postnuptial molt when the tail feathers and outer primaries are being replaced. Their diet undergoes another change at this time, weevils and lepidopterous larvæ again taking the ascendency, for there is but little vegetable food available in the open marsh at this time.

About the middle of September the adult males again come into evidence, and are seen once more on the uplands by day. They commenced the molt about two weeks earlier than the females and young, and having now completed it, they appear again about two weeks sooner. During the molting period the males and females occurred in mixed flocks, but from now on, with scarce an exception, they are segregated. Shortly the females and immature birds come more into evidence about the borders of the marsh, and by the first of October are as regular in their movements as the males, spending their days on the uplands and coming to the marsh each night to roost.

Well-defined migration begins about the middle of October. At that time all loitering ceases, and the evening and morning flights in and out of the marsh are very regular, scarcely a bird lingering during the day. Beginning about three-fourths of an hour before, and continuing about half an hour after the sun has disappeared behind the hills, they can be seen in flocks of from ten to a thousand continually dropping into the marsh.

A single roosting place seems to be selected toward which all the birds direct their way. In the extensive Montezuma Marshes, at the foot of Cayuga Lake, this roost is frequently at the northerly end, so that birds coming in from the south often fly over miles of marsh before reaching the place. With them are often associated Cowbirds, Grackles, and Rusty Blackbirds. The form of the flock is rather irregular, but always with the long axis at right angles to the direction of flight (Plate VIII, fig. 1), thus differing from the characteristic form of the flocks of Grackles which sometimes extend for over a mile in length, although only a few rods wide. The maximum flight occurs at sundown. The morning flight is not so regular as that in the evening, and it extends over a shorter period. Beginning a few minutes before sunrise, flocks are continually in sight for about thirty minutes. Their formation is open and they vary in numbers, from a few to over ten thousand birds, the largest flocks extending to the east and to the west as far as the eye can see, but generally not more than a hundred birds deep. During the evening flight the sexes are generally in separate flocks, except for some of the last birds to arrive, among which there is a considerable mixture. The method of segregation of these birds in the morning flight is interesting. A single male or a small group of males, finding themselves in a flock of females, drop out of the ranks and await the appearance of a flock of their own sex, or until their own numbers are sufficiently augmented to form a flock of some size, when they are again up and away. Half an hour after the morning flight has commenced, scarcely a Redwing is to be found in the marsh. The fall migration continues until about the middle of November. The last birds seen are generally scattered flocks of females.

ENEMIES.

Reference has already been made to some of the enemies or forces which tend toward the destruction of the Redwings. The presence of Minks and Weasels in the marsh has been mentioned. In the same category with them might be placed the Marsh, Sharp-shinned, Cooper's, and Pigeon Hawks, which frequently strike terror into the ranks of Redwings. It is the Long-billed Marsh Wren, however, that is accountable for the greatest devastation. Chapman (1900) comments upon this bird's destructiveness to the eggs of the Least Bittern. In the spring of 1911, I observed it destroying the eggs of a Red-winged Blackbird. While I was standing near a nest containing two eggs, I noticed a peculiarly acting Marsh Wren about thirty feet away. The vivacious notes so characteristic of this species were not uttered. It made its way through the vegetation directly toward the nest until within about ten feet of me, when it began to circle. After I had retired to a distance of about fifteen feet, the Wren went without hesitation straight to the nest, hopped upon the rim, and, bending forward, delivered several sharp blows with its beak upon one of the eggs. It then began to drink the contents much as a bird drinks water. After a few sips, it grasped the eggshell in its beak and flew off into the marsh, where it continued its feast. Upon finishing the contents, it fluttered up to a near-by cat-tail, where, for the first time during the whole period, it burst into song. How general this egg-eating habit of the Marsh Wren may be, is unknown. It seems very strange, however, in view of the friendly terms upon which it seems to live with the Redwing, for nests of both birds are not infrequently found in close proximity. That cases are not isolated is shown by the fact that of 51 nests of the Redwing observed in a limited area, the eggs of 14 were destroyed in this or in a similar way, and it is not at all uncommon to find one or more of the eggs of a nest with neat, circular holes in one side, such as would be made by the small, sharp beak of a Wren.

The way in which nests are destroyed by the growth of vegetation has already been commented upon (Plate XVII, figs. 1 and 2).

A list of the parasites found upon the Redwing has been prepared for me by Mr. A. R. Thompson, and is presented herewith:

Mallophaga:
- *Docophorus agelaii* Osborn

PLATE XVII.

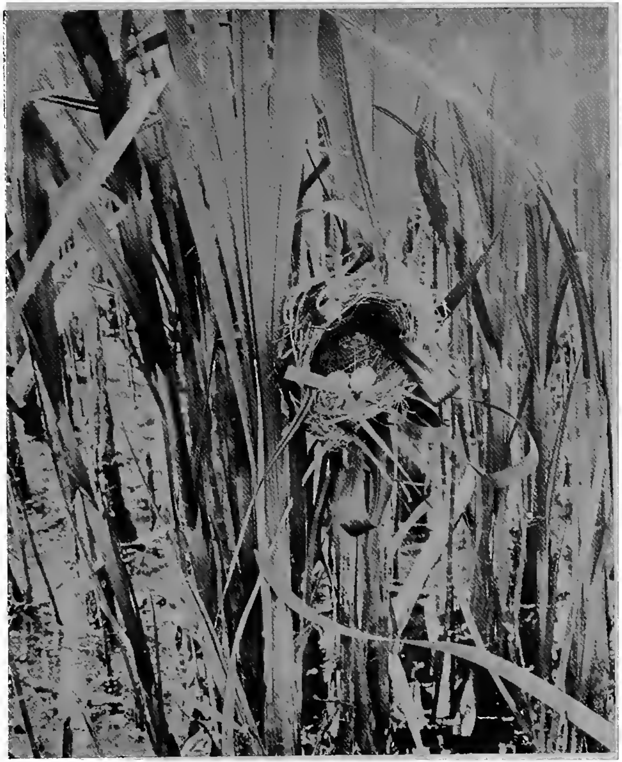


Fig. 1.—Nest overturned by the growth of the vegetation.

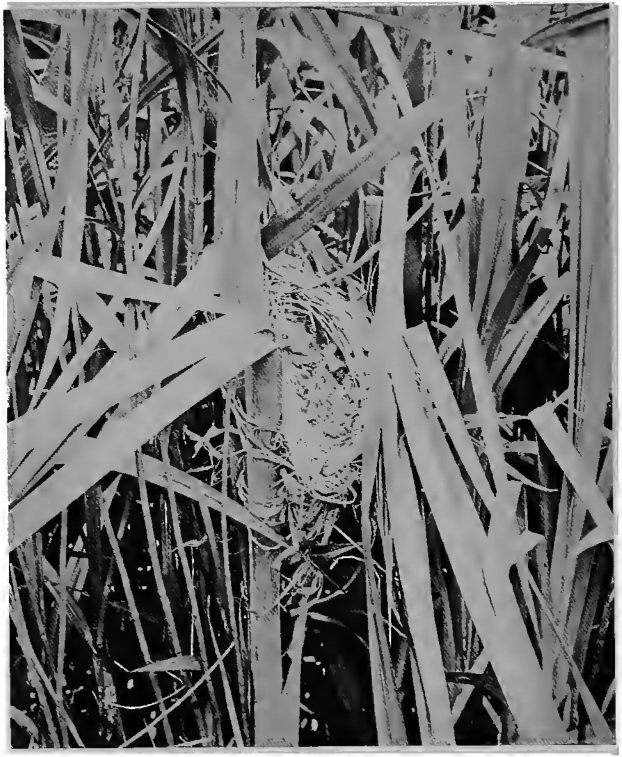


Fig. 2.—Nest compressed by the growth of the vegetation.

Nirmus illustris Kellogg
Nirmus ornatissimus Giebel

Acarina:
Cnemidocoptes fossor Ehlers
Proctophyllodes indefensus Thompson, sp. nov.
Pterodectes sp.
Syringophilus elongatus Ewing

The effect of *Cnemidocoptes* upon the feet of the Redwing is shown in Plate XX, fig. 1. Such abnormal feet are by no means uncommon, and can be identified in the field even at a considerable distance.

MOLT AND PLUMAGE.

The most complete and authoritative account of the molting and plumages of the Redwing is that by Dwight (1899). He writes:

"1. *Natal Down.* Pale mouse-gray.

"2. *Juvenal Plumage* acquired by a complete postnatal moult.

"Above . . . dull brownish black (no red at this stage), the feathers edged with buff. . . . Below pinkish buff, ochraceous on the chin, thickly streaked (except on the chin) with brownish black. . . .

"3. *First Winter Plumage* acquired by a complete postjuvenal moult beginning towards the end of August. Resembles previous dress, the general effect being that of a brown streaked bird, the black being heavily veiled by brown feather tips, and mottled orange 'shoulders' are acquired.

"4. *First Nuptial Plumage* acquired by wear which is considerable, birds becoming a dull brownish black by loss of the feather edgings and by fading. The mottled 'shoulder patches' are characteristic of young birds, the amount of orange varying greatly. The wings and tail show marked wear.

"5. *Adult Winter Plumage* acquired by a complete postnuptial moult beginning in mid-August, young and old becoming practically indistinguishable.

"6. *Adult Nuptial Plumage* acquired by wear which produces less marked effects than in the young birds. The exposed edges of the buff median coverts fade to a dull white. The more resistant nature of the adult feathers is strikingly shown by this species, the worn and faded remiges and retrices of young birds contrasting sharply with those of adults.

"*Female.*—In natal down and juvenal plumage females differ little from males, the juvenal dress perhaps averaging browner above with less buff below and the chin narrowly streaked. The first winter plumage is acquired by a complete postjuvenal moult as in the male, from which the female now differs widely, being brown and broadly streaked. The first winter plumage is hardly distinguishable from the adult winter and passes into the first nuptial by wear which produces a black and white streaked bird, brown above. A pinkish or salmon tinge is often found in females in any of these plumages especially about the chin and head and an orange or crimson tinge may show on the 'shoulders' of the older birds."

These excellent descriptions, together with such innate variation as is likely to occur, account for practically every plumage. Certain birds, however, seem to show greater difference than would be allowed for by ordinary variation. The difference is most noticeable in the spring. These specimens resemble the adult males in having the bright scarlet shoulder patches, which, however, are occasionally flecked with black, and in the greater gloss to the feathers. They resemble the immature males in the first nuptial plumage in the persistence of the buffy and rusty edgings to the feathers and in the decidedly worn brownish remiges and rectrices. This plumage is thus intermediate between the immature and adult plumages as described by Dwight. The regularity of its occurrence leads me to believe that it frequently requires more than two years for the fully adult plumage to be acquired, and that these represent birds of the second year.

Food and Food Supply.

The food of the Red-winged Blackbird has received so much attention on account of its economic importance that it is impossible to quote all that has been written on the subject.

From the time of the early settlers, when it was obligatory to kill a certain number annually or pay a fine (Allen, 1876), to the time when Beal (1900) completed his examination of over a thousand stomachs, its food and feeding habits have been dwelt upon at length. The more important discussions of the food of the Redwings will be found in the following references:

Wilson, A., 1831.
Audubon, J. J., 1831.
Baird, Brewer, and Ridgway, 1874.
Allen, J. A., 1876.
Goss, N. S., 1883.
Warren, B. H., 1890.
Shriner, C. A., 1896.
Wayne, A. J., 1899.
Beal, F. E. L., 1900.
Forbush, E. H., 1907.
Peet, M. M., 1908.

For the most part these observations have been made, and the results summarized, from an economic standpoint. An ecological summary would impose an extremely difficult and unsatisfactory task, if one were to attempt to include everything that has been written. From such a standpoint, food studies are valuable only when correlated with the various phases in the life history of the bird. Intensive studies are therefore more suggestive than extensive ones, because each change in food is thus brought into close relation with the synchronous phase of the life history. It is for this reason that during the three seasons of work over one hundred birds have been collected and the food content of their stomachs tabulated.

A summary of Beal's studies shows that "The food of the year was found to consist of 73.4 per cent of vegetable matter and 26.6 per cent of animal. The animal food begins with 1.4 per cent in January and gradually increases to 88.2 per cent in June, after which it regularly decreases to a fraction of 1 per cent in November. With the exception of a few snails and crustaceans, it consists entirely of insects and their allies (spiders and myriapods), so that, roughly speaking, insects constitute one fourth of the year's food. They consist principally of beetles, grasshoppers, and caterpillars, with a few wasps, ants, flies, bugs, and dragon-flies. . . . The vegetable food of the redwings consists mainly of seeds of grasses and weeds, the different kinds of grain being merely larger or more important grasses."

That this change in food takes place is in itself very interesting, but the explanation for it would be much more so. Beal goes on to suggest an explanation which is very plausible, and which would undoubtedly have received additional support, had his studies been more intensive or had they included more than the food. He states: "The diagram on p. 38 shows in a striking manner the increase of the animal food in early summer —that is, in June. It is probable that the exhaustive labors of reproduction call for a more exclusively animal diet in May and June than does the strain of moulting in July and August. There seems to be no other theory by which to explain the decrease in the latter month, especially in view of the fact that these are the months when grasshoppers abound."

In the present work, an effort has been made to study the changes in the Redwing's food in the light of synchronous changes in the environment and correlated changes in the available food supply. Likewise, an attempt has been made to determine changes which take place within the birds themselves, especially in connection with the alimentary canal and the reproductive organs. Inasmuch as there is such a difference in the available food supply of the marsh and of the uplands, it is of prime importance always to bear in mind the locality in which the birds have been feeding. In general, most of the food of the migrating birds is secured on the uplands, and that of the resident birds, in the marsh. But those migrants which are the first to arrive in the evening and the last to leave in the morning, feed to a greater or less extent in the marsh. As these are most easily collected, a considerable number of the migrating birds will be shown in the table as finding their food in the marsh, and allowances must be made therefor. The normal difference between the food of migrating and resident birds is so great that allowances should be made also in applying Beal's curves to the life history of individuals, for his data probably include both migrating and resident birds on the same date. The following table includes the result of the studies made in Renwick Marsh. The nature of

Date.	Nature of Bird.	Food Secured Where.	Vegetable Food.		Animal Food.	
			Per Cent.	Forms Occurring.	Per Cent.	Forms Occurring.
Feb. 27, '11...	"Vagrant" immature male	Marsh	0	....	100	Lepidopterous larvæ, 5 Lepidopterous pupæ, 1
Mar. 7, '10...	Migrant adult male	Marsh	0	....	100	Rhyncophora Myriapoda Coleoptera (misc.)
Mar. 7, '10...	Migrant adult male	Marsh + uplands	0	....	100	Rhyncophora Orthoptera Myriapoda Hemiptera Carabidæ, adults Carabidæ, larvæ
Mar. 8, '10...	Migrant adult male	Uplands	0	....	100	Hymenoptera, 1 Hemiptera, 1 Myriapoda, 2 Carabidæ, adults, 3 Carabidæ, larvæ, 2 Orthoptera
Mar. 8, '10...	Migrant adult male	Marsh	5	Not identified	95	Rhyncophora
Mar. 8, '10...	Migrant adult male	Marsh	95	Not identified	5	Rhyncophora
Mar. 8, '10...	Migrant adult male	Marsh	40	Not identified	60	Rhyncophora
Mar. 13, '11...	Migrant adult male	Marsh	0	....	100	Rhyncophora, 28 Carabidæ, adults, 3
Mar. 15, '11...	Migrant adult male	Marsh	5	*Scirpus* seeds, 2	95	Rhyncophora Arachnida, 4 Carabidæ, adults, 3 Dipterous larvæ, 1
Mar. 18, '11...	Migrant adult male	Uplands	98	Not identified	2	Carabidæ, 1
Mar. 22, '11...	Resident adult male	Marsh	0	....	100	Dipterous pupæ, 26 Rhyncophora, 3
Mar. 18, '11...	Migrant adult male	Uplands	98	Not identified	2	Formicidæ, 2

Date.	Nature of Bird.	Food Secured Where.	Vegetable Food.		Animal Food.	
			Per Cent.	Forms Occurring.	Per Cent.	Forms Occurring.
Mar. 27, '11...	Resident adult male	Marsh	0	....	100	Lepidopterous larvæ, 10% Rhyncophora, 90%
Mar. 29, '11...	Resident adult male	Marsh	0	....	100	Rhyncophora
Mar. 30, '09...	Resident adult male	Uplands	98	Foxtail grass, 97% Ragweed, 2% Grain, 1%	2	Lepidopterous larvæ, 7 Arachnida, 1
Mar. 30, '09...	2 migrant adult males	Uplands	90	Ragweed, 3% Foxtail grass, 97% (1,500 seeds)	10	Lepidopterous larvæ, 12 Arachnida, 5
Mar. 31, '09...	Migrant adult male	Uplands	50	Not identified	50	Lepidopterous larvæ Lepidopterous pupæ
Mar. 31, '09...	Migrant adult male	Uplands	85	Not identified	15	Carabidæ, adults
Mar. 31, '09...	Migrant adult male	Uplands	50	Not identified	50	Carabidæ, adults
Apr. 1, '11...	Migrant imm. male	Uplands	99	Foxtail grass	1	Lepidopterous larvæ
Apr. 1, '11...	Migrant female	Uplands	99	Foxtail grass (816 seeds) Unidentified seeds, 6	1	Lepidopterous larvæ
Apr. 6, '11...	Migrant imm. male	Uplands	90	Foxtail grass	10	Lepidopterous larvæ, 3
Apr. 8, '11...	Resident adult male	Marsh	0	....	100	Rhyncophora Lepidopterous larvæ, 2
Apr. 10, '11...	Migrant adult female	Uplands	100	Foxtail grass	0	....
Apr. 11, '11...	Resident adult male	Marsh	0	....	100	Rhyncophora Lepidopterous larvæ
Apr. 12, '10...	Migrant adult male	Marsh border	50	*Scirpus* (18 seeds) Cut-grass (30 seeds)	50	Coleoptera (misc.)
Apr. 12, '10...	Migrant adult female	Marsh border	95	*Scirpus* (9 seeds) Cut-grass (75 seeds)	5	Rhyncophora
Apr. 13, '10...	Migrant male	Uplands	50	Grain (rye)	50	Coleoptera (misc.)
Apr. 15, '11...	Resident adult female	Marsh	0	....	100	Dipterous pupæ, 25% Carabidæ, 35% Rhyncophora, 40%

Date.	Nature of Bird.	Food Secured Where.	Vegetable Food.		Animal Food.	
			Per Cent.	Forms Occurring.	Per Cent.	Forms Occurring.
Apr. 15, '11...	Resident adult male	Marsh	0	....	100	Rhyncophora
Apr. 18, '11...	Migrant adult male	Uplands	20	Ragweed	20	Rhyncophora Lepidopterous larvæ Arachnida
Apr. 20, '11...	Migrant male	Marsh border	80	*Polyganum persicaria*	20	Lepidopterous larvæ Carabidæ, larvæ Tabanidæ, larvæ
Apr. 20, '11...	Migrant female	Marsh	0	....	100	Rhyncophora
Apr. 21, '11...	Resident male	Marsh	0	....	100	Dipterous larvæ Arachnida Coleoptera
Apr. 21, '09...	Migrant female	Uplands	80	Foxtail grass	20	Lepidopterous larvæ, 2 Planorbus, 1 Dolichopodidæ, 2 Coleoptera
Apr. 21, '09...	Migrant male	Uplands + marsh	10	Foxtail grass	90	Coleoptera Arachnida Dipterous larvæ
Apr. 21, '09...	Resident male	Marsh	0	....	100	Lepidopterous larvæ, 3 Rhyncophora, 1
Apr. 26, '10...	Resident male	Marsh	0	....	100	Lepidopterous larvæ, 18 Rhyncophora, 18 Capsidæ, 2
Apr. 26, '10...	Migrant male	Marsh	0	....	100	Lepidoptera Rhyncophora Coleoptera (misc.)
Apr. 26, '10...	Resident male	Marsh	2	Not identified	98	Tabanidæ, larvæ, 18 Rhyncophora, 3
Apr. 26, '11...	Resident male	Marsh	0	....	100	Rhyncophora Tabanidæ, larvæ

Date.	Nature of Bird.	Food Secured Where.	Vegetable Food.		Animal Food.	
			Per Cent.	Forms Occurring.	Per Cent.	Forms Occurring.
May 5, '09...	....	Marsh	0	....	100	Lepidopterous larvæ Coleoptera *Chauliodes*, larvæ
May 5, '09...	....	Marsh	0	....	100	Muscidæ, larvæ, 57 Strathiomyiadæ, larvæ, 1 Rhyncophora Coleoptera (misc.)
May 5, '09...	....	Marsh	0	....	100	Lepidopterous larvæ Arachnida Coleoptera
May 5, '09...	....	Marsh	0	....	100	*Chauliodes*, larvæ Rhyncophora Arachnida Coleoptera Strathiomyiadæ, larvæ
May 6, '11...	Resident adult female	Marsh	0	....	100	Lepidopterous larvæ, 8 Rhyncophora, 1 Arachnida, 1 Snail shell
May 6, '11...	Resident adult male	Marsh	0	....	100	Lepidopterous larvæ, 9 Rhyncophora, 1
May 10, '11...	Resident adult female	Marsh	0	....	100	Lepidopterous larvæ, 3 Rhyncophora (fragments)
May 10, '11...	Resident adult male	Marsh	0	....	100	Lepidopterous larvæ, 7 Rhyncophora (fragments)
May 10, '11...	Migrant imm. male	Uplands	90	Oats	10	Coleoptera
May 26, '09...	Resident male	Marsh	0	....	100	Dipterous larvæ, 24 Arachnida, 6 Rhyncophora, 6

Date.	Nature of Bird.	Food Secured Where.	Vegetable Food.		Animal Food.	
			Per Cent.	Forms Occurring.	Per Cent.	Forms Occurring.
May 26, '09...	Resident male	Marsh	0	....	100	*Chauliodes*, 98% Rhyncophora, 2%
May 26, '09...	Resident male	Marsh	1	....	99	*Chauliodes* *Donacia* Dipterous larvæ
May 26, '09...	Resident male	Marsh	0	....	100	*Chauliodes*, 1 Dipterous larvæ Rhyncophora, sev.
June 16, '09...	Resident male	Marsh	0	....	100	*Donacia*, 95% Dipterous larvæ, 5%
June 16, '09...	Resident male	Marsh	0	....	100	*Donacia*
June 16, '09...	Resident male	Marsh	0	....	100	*Donacia*
July 10, '12...	Resident immature	Marsh	75	Grass seed	25	Rhyncophora
July 10, '12...	Resident immature	Marsh	0	....	100	Rhyncophora Dipterous larvæ Lepidopterous larvæ
July 10, '12...	Resident adult	Marsh	0	....	100	Rhyncophora Neuroptera
July 10, '12...	Resident adult	Marsh	0	....	100	Rhyncophora Lepidopterous larvæ
July 10, '12...	Resident adult	Marsh	0	....	100	Rhyncophora Lepidopterous larvæ
July 10, '12...	Resident adult	Marsh	50	?	50	Rhyncophora
Aug. 21, '12...	Resident adult	Uplands	100	Grain	0	....
Aug. 21, '12...	Resident adult	Uplands	95	Grain	5	Jassidæ
Aug. 21, '12...	Resident adult	Uplands	95	Grain	5	Rhyncophora
Aug. 23, '12...	Resident adult	Marsh	50	*Polyganum*	50	Rhyncophora
Sep. 13, '12...	Resident adult	Marsh	95	*Polyganum*	5	Rhyncophora
Sep. 13, '12...	Resident adult	Marsh	.5	*Polyganum*	95	Rhyncophora
Sep. 13, '12...	Resident adult	Marsh	0		100	Rhyncophora

Date.	Nature of Bird.	Food Secured Where.	Vegetable Food.		Animal Food.	
			Per Cent.	Forms Occurring.	Per Cent.	Forms Occurring.
Sep. 13, '12...	Resident adult	Marsh	95	*Polyganum*	5	Rhyncophora
Sep. 13, '12...	Resident adult	Marsh	95	*Polyganum*	5	Rhyncophora
Oct. 6, '09...	Resident male	Marsh	2	....	98	Carabidæ
Oct. 6, '09...	Resident male	Uplands	95	Foxtail grass	5	Carabidæ
Oct. 6, '09...	Resident male	Marsh	1	....	99	Carabidæ
Oct. 14 & 21, '09	15 migrants	Marsh + uplands	80	Foxtail grass, 98% Ragweed + bindweed, 1% wheat + corn, 1%	20	*Donacia*, 50% Rhyncophora, 20% Jassidæ, 8 Aphidæ, 8 *Hyalella*, 2 Muscidæ, 2 Noctuidæ, pupæ, 2 Arachnida, 2 *Gammarus*, 1 Psocidæ, 1 Dipterous larvæ, 1 Tenthredinidæ, 1 Phalangidæ, 1 Dermestidæ, 1
Oct. 26, '09...	Migrant	Uplands	99	Ragweed seed	1	Lepidopterous larvæ
Oct. 26, '09...	Migrant	Uplands	99	Wheat, 50% Ragweed + foxtail grass, 50%	1	Jassidæ, 2
Oct. 26, '09...	Migrant	Uplands	95	Wheat, 45% Ragweed + foxtail grass, 55%	5	Jassidæ Lepidopterous larvæ Cerambycidæ
Oct. 26, '09...	Migrant	Uplands + marsh	99	*Polyganum virginianum*	1	*Cnemidotus duodecimopunctatus*, 1

Date.	Nature of Bird.	Food Secured Where.	Vegetable Food.		Animal Food.	
			Per Cent.	Forms Occurring.	Per Cent.	Forms Occurring.
Oct. 26, '09...	Migrant	Uplands	98	Corn, 75% Ragweed + foxtail grass, 25%	2	Jassidæ, 1 Rhyncophora, 1 Arachnida, 1
Nov. 8, '09...	Migrant	Uplands	98	Ragweed + foxtail grass, 99% Wheat, 1%	2	Lepidopterous larvæ, 2
Nov. 8, '09...	Migrant	Uplands	100	....	0	....
Nov. 8, '09...	Migrant	Uplands	100	Ragweed, 45% Foxtail grass, 45% Wheat, 8% *Geum strictum*, 2%	0	....
Nov. 8, '09...	Migrant	Uplands	100	Ragweed, 45% Foxtail grass, 45% Oats, 10%	0	....

the food, whether animal or vegetable, is given in bulk percentages and is followed by a list of the seeds or insects identified. Reference has already been made in a general way to the food at the different seasons, but it will now be taken up in greater detail.

Food during the Spring Migration.—Although this period is, in reality, not complete until nearly the middle of June, when the last immature females arrive, it will be considered in the present connection as extending only up to the time of mating, which is about the 20th of April. As before stated, the food at this season is secured largely upon the uplands, and is very different from that secured in the marsh. The data given in the table include more than a fair average of birds which have been feeding in the marsh, and therefore the two types of food will be taken up separately. Under the title of "food secured in the marsh" will be included that of the resident birds up to the time of mating, as well as that of the migrants.

Food Secured on the Uplands.—By far the greater part of this food is vegetable, ranging between 90 and 100 per cent in nearly half of the stomachs examined. Some birds, however, find sufficient insect life on the hills to bring down the average for the 18 stomachs examined to 66 per cent of vegetable food. Of this, the seeds of foxtail grass (*Setaria glauca*) and of ragweed (*Ambrosia artemisæfolia*) constitute the largest part, with a trace of grain (corn and rye) next. In the crop and stomach of one female were 816 seeds of foxtail grass, and in two others, 1,500 of the same seeds. In the 34 per cent of insect food, lepidopterous larvæ predominate, with Caribidæ (ground beetles) and their larvæ next, and centipedes, grasshoppers, and miscellaneous Coleoptera following (Plate XVIII, fig. 1).

Food Secured in the Marsh.—As before stated, the marsh at this time of the year is flooded and vegetable food is scarce. The seeds of strictly marsh plants are not available for various reasons, and all that are secured must be picked from the marsh border. Here are found sufficient seeds of cut-grass (*Leerzia*) and the like to bring up the total to 19 per cent. Thirteen out of the 20 birds examined, however, had secured

PLATE XVIII.

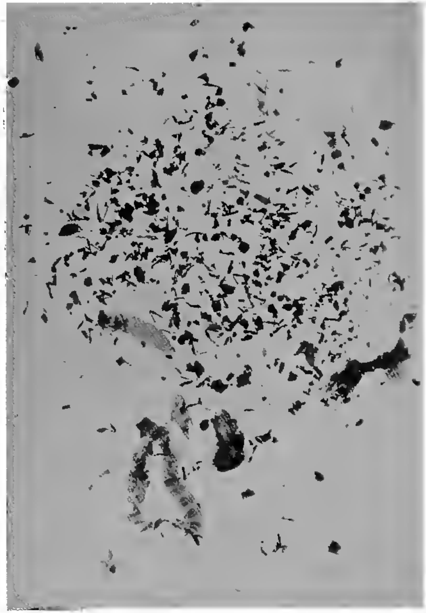
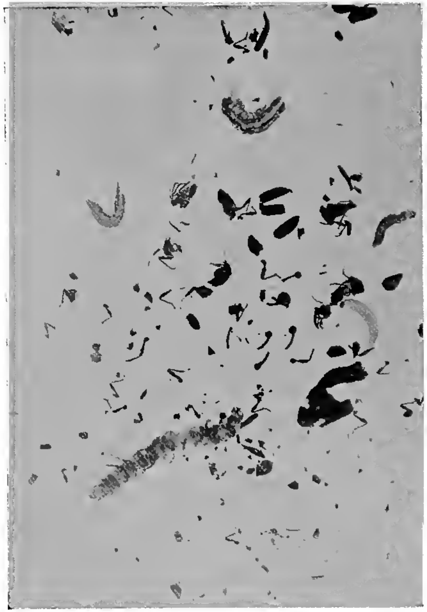


Fig. 1.—Secured on uplands
Mar. 7–Apr. 21.



Animal content of typical stomachs.
Fig. 2.—Secured in marsh
Mar. 7–Apr. 21.

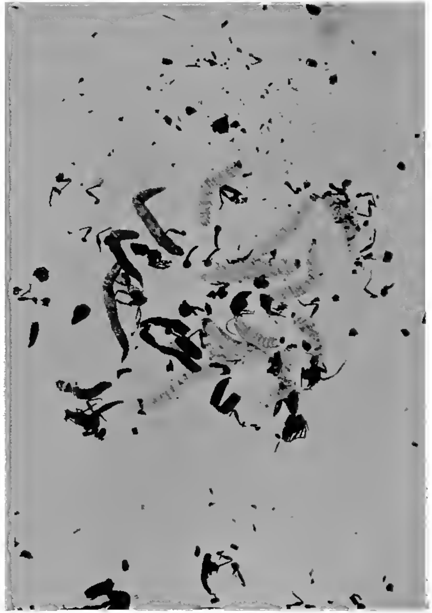


Fig. 3.—Secured in marsh
Apr. 21–May 7.

PLATE XIX.

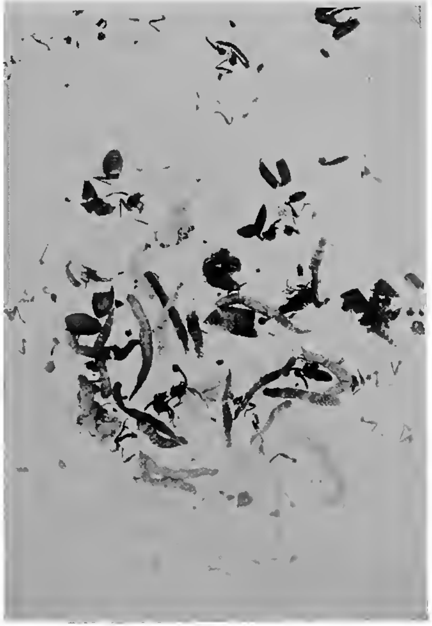
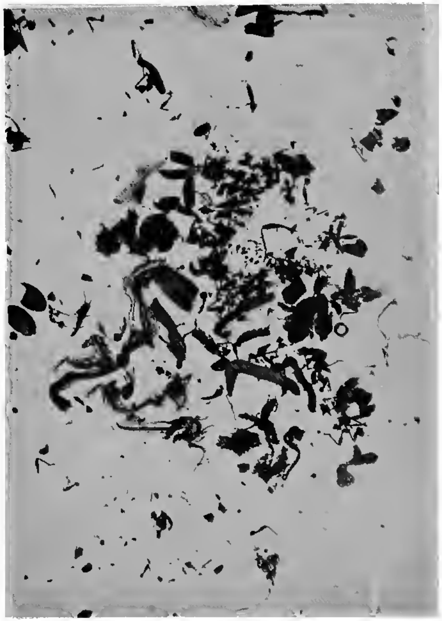


Fig. 1.—May 7–26.



Animal content of typical stomachs.
Fig 2.—May 26–June 16.

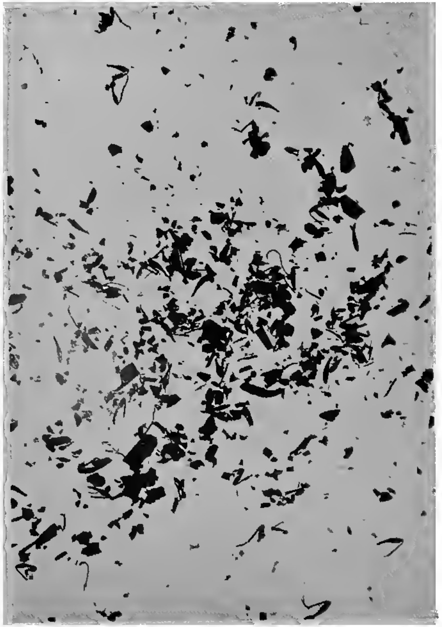


Fig 3.—June 16–July 1.

no vegetable food whatsoever. Of the animal food, weevils of several species form by far the greatest percentage, seven birds having fed upon them to the exclusion of everything else. Next in order of abundance are lepidopterous larvæ, ground beetles, spiders, and centipedes, with dipterous larvæ beginning to appear (Plate XVIII, fig. 2). These are the forms that are found in greatest numbers in the marsh at this season. With the disappearance of the ice in the spring, the first insects to appear from hibernation are the weevils, which occur in large numbers, but are inconspicuous because of their secretive habits. Lepidopterous larvæ, though numerous, are even more difficult to find. In the drier portions, and often on floating logs and debris, are numerous ground beetles and centipedes. Other forms are exceedingly scarce. Toward the latter part of April numerous dipterous (tabanid) larvæ appear floating on the surface, and at once form a part of the Redwing's food.

Food during the Mating Period.—This period extends from the third week in April through the first week in May (April 21–May 7). At this time food is secured by the resident birds entirely in the marsh, and is practically 100 per cent animal. The vegetation in the marsh has obtained a good start, and furnishes forage for large numbers of lepidopterous larvæ, which now take the ascendancy in the food. Dipterous larvæ follow a close second, with weevils, spiders, and ground beetles more numerous than before, but now in the background (Plate XVIII, fig. 3).

Food during the Breeding Season.—This shows a series of changes which are closely correlated with the appearance and disappearance of the predominant insects in the marsh. At first the lepidopterous larvæ continue to predominate, but frequently are superceded by dipterous larvæ, which are found at the surface of the water before transformation. *Chauliodes* larvæ, crawling out of the water to pupate, appear and disappear in the food very abruptly. Rhyncophora and other Coleoptera continue (Plate XIX, fig. 1). Toward the last of May another decided change takes place, when the fish flies (*Chauliodes*) transform and furnish abundant and easy forage;

at this time they occur even more abundantly in the Redwing's food than do the dipterous larvæ, which are still very numerous. Weevils and lepidopterous larvæ continue to occur, and beetles of the genus *Donacia* begin to appear (Plate XIX, fig. 2). Between the last of May and middle of June other changes probably take place, such as by the transformation of caddis flies and May flies, which are known to form an important item in their food. About the middle of June, however, there suddenly appear in the marsh great hosts of *Donacia*, which in a few days overrun everything, and arise in swarms ahead of one who walks through the sedges and burreeds. They are so abundant and so readily captured by the Redwings that they constitute nearly 100 per cent of its food at this season. Among the few other insects taken, dipterous larvæ predominate (Plate XIX, fig. 3).

Food during the Molting Season.—The diet of *Donacia* continues until the birds begin to flock and fly to the uplands in July. At this time the percentage of animal food decreases to nil. With the retirement to the marsh in late August for the latter part of the molting season, however, the percentage of animal food again increases, as there are but few seeds available in the open marsh at this season. In it weevils and lepidopterous larvæ predominate, while several species of *Polyganum* supply the greater part of the vegetable food. This augmentation of the animal diet is but temporary, for as soon as the Redwings begin flying to the uplands again in late September, the percentage of animal food steadily decreases.

Food during the Fall Flocking.—In October, during what we may call the period of fall flocking, animal food constitutes but 18 per cent. At this season of the year food is secured mostly from the uplands, but in the evening and morning some is secured from the marsh. A study of the insects eaten shows a great variety, but *Donacia* and Rhyncophora predominate. The vegetable food is very similar to that of the spring, being largely the seed of the one grass, *Setaria glauca*, with an admixture of the seeds of other grasses, ragweed, and bindweed.

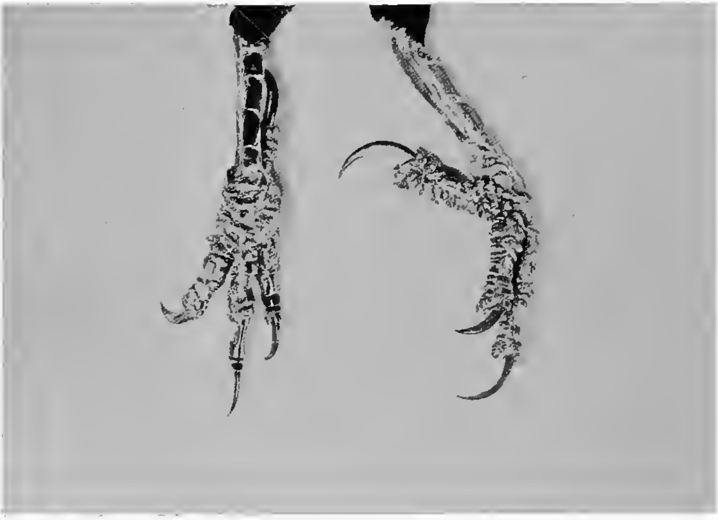


FIG. 1.—ABNORMAL FEET OF REDWING CAUSED BY THE MITE, *Cnemidocoptes fossor*.

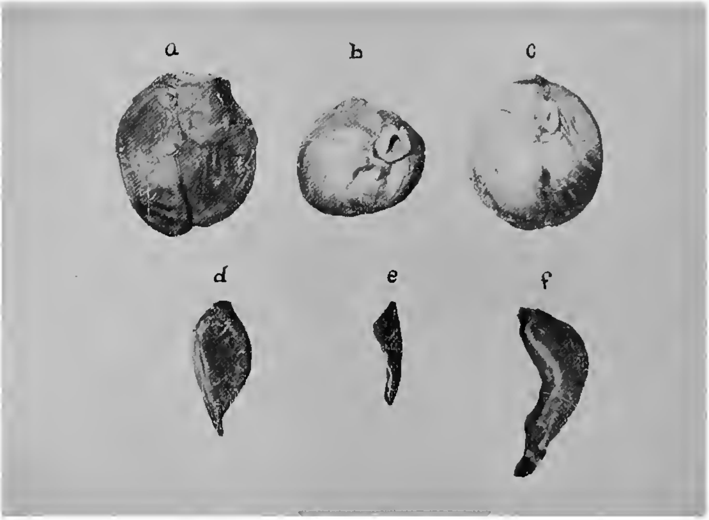


FIG. 2.—GIZZARDS OF REDWINGS, SHOWING THE CORRELATION BETWEEN FOOD AND MUSCULATURE.

Food during the Fall Migration.—By the last week in October the migration is well under way, and the Redwings spend very little time in the marsh. The food is taken entirely from the uplands, and is practically 100 per cent vegetable; it is composed chiefly of the seeds of foxtail grass and ragweed, with a little grain (corn, wheat, and oats) interspersed. This diet continues throughout the migrating period, which ends about the middle of November.

Such are the changes occurring—changes which pass through all stages from a strictly herbivorous to a totally insectivorous diet, and which must demand an exceptional adaptability as well as a most generalized structure. In conclusion, it may be stated that the Redwings feed upon whatever is most available; that during the migrating periods of spring and fall they obtain their food upon the uplands, where the seeds of foxtail grass and ragweed are most abundant; that during the breeding season they obtain their food in the marsh, where only animal food is available; that here their food is limited only by their powers of capture, and varies with the species predominating in the marsh.

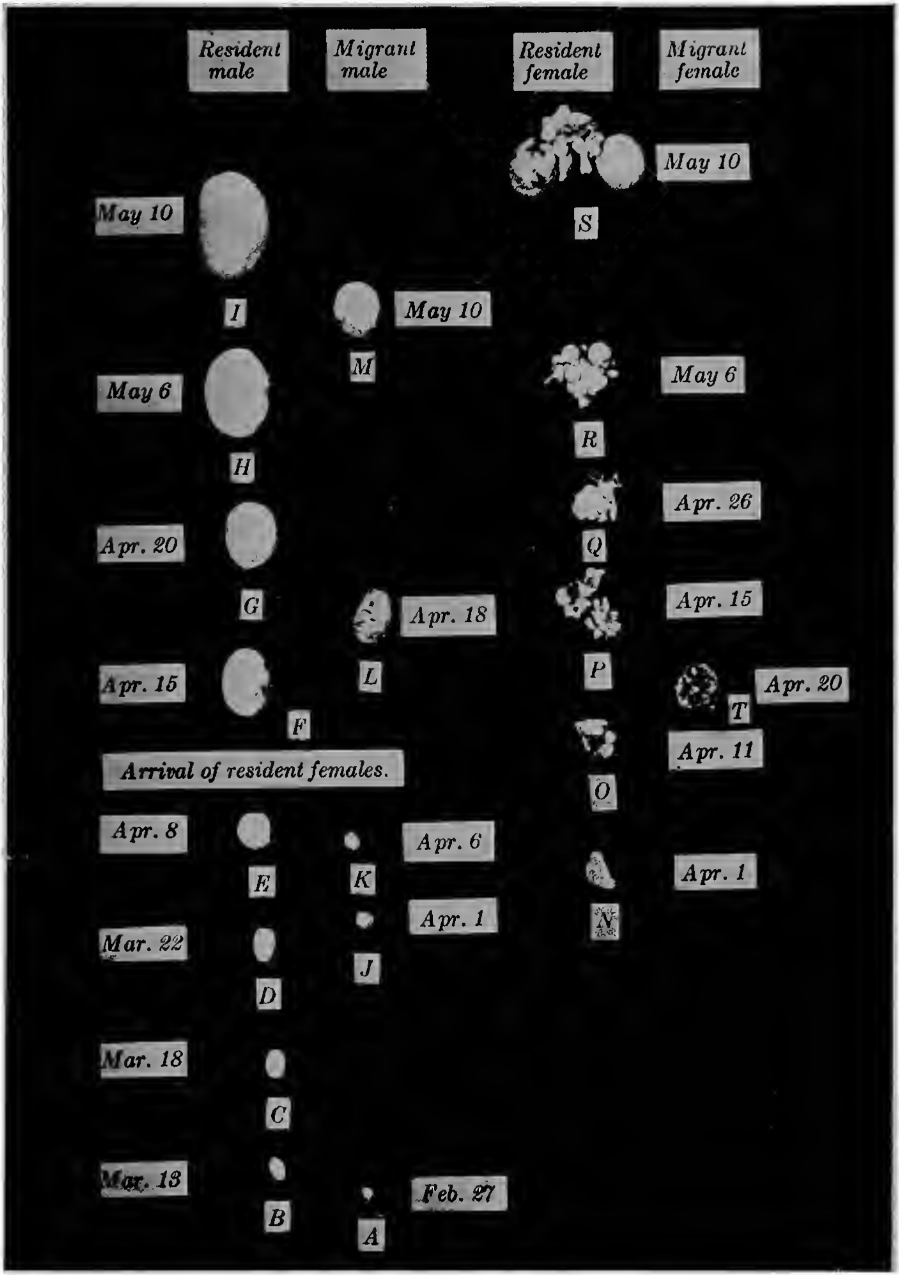
CORRELATION BETWEEN CHANGES IN FOOD AND CHANGES IN STRUCTURE OF STOMACH.

Along with the change in diet from seeds to insects and from insects to seeds, there is a corresponding change in the nature of the gizzard. The comparatively soft-bodied insects do not require the muscular strength that is necessary to grind the hard seeds, so that with the decrease in the amount of vegetable food eaten, there is a corresponding degeneration in the musculature of the ventriculus. This is well shown in Plate XX, fig. 2, where the stomachs of a migrating bird and a resident bird, taken on the same day, are opposed (*B* and *C*). The migrant had not yet begun its insectivorous diet, whereas the resident had been feeding upon insects for at least a month. A similar difference is shown between the stomachs of the two resident birds taken, one at the time of first establishment in the marsh, and the other after a month's residence (*A* and *B*).

CORRELATION OF THE CHANGES OCCURRING IN THE REPRODUCTIVE ORGANS.

The development of the reproductive organs shows a somewhat similar condition. The testes of the males will be first considered. The first "vagrants" to arrive in the spring show but slight enlargement (Plate XXI, *A*). In the first migrants to arrive the increase is more evident (*B*). Enlargement takes place at a fairly uniform rate (*C* and *D*) until the arrival of the adult females, when the rapidity of growth is greatly increased (*F*). The males are now spending their entire time in the marsh and feeding upon an exclusively insectivorous diet. This rapid increase does not occur in the birds which are migrating, but only in the resident birds. (The migrant birds, however, are immature, and therefore may not be strictly comparable.) After this sudden enlargement, growth continues at a uniform rate until the mating period (*G*, *H*, *I*), when the maximum is reached. The rate of growth of the testes of the immature migrant birds is much less than that of the residents, as is well shown in the plate (*J*, *K*, *L*, *M*), those of the adult resident bird on May 10 being fully twice the size of those of the immature migrant of the same date. That the sudden enlargement occurring after the arrival of the resident females and during the subsequent days spent in the marsh, and that the difference in degree of development between the resident and migrating birds, is largely due to the nature of the food, can not, of course, be stated, although there is some ground for so believing. It is probable that the presence of the females serves to stimulate the growth, but it may well be that the animal food is necessary to support it.

When the migrant females first arrive, their ovaries are in a relatively less mature condition than were the organs of the males upon their arrival a month earlier, the ova being of microscopic size (Plate XXI, *N*). Enlargement is fairly rapid, however, so that by the time the first resident females appear the largest ova are about 1½ millimeters in diameter (*O*). Mating occurs while the ova are still immature (*P*), and the nest is commenced just as the deposition of yellow yolk is



Stages in the development of the testes and ovaries of Redwings, showing the rate of growth.

begun about the most mature ovum (*R*). By the time the nest is finished, the first ovum is ordinarily complete with its yolk; in the next twenty-four hours it passes down the oviduct, where it receives the albumen and shell, and is emitted on the day following the completion of the nest. This process is repeated each day, a second egg falling into the oviduct about the time the first is deposited, until the complement is complete. The development of the ova in the migrating females is much slower than that in the resident birds, as is shown in the plate (*T*). The ova in this ovary were smaller on April 20 than were those of the resident bird on April 11. This helps to substantiate the belief first intimated by Beal (1900), that there is a direct correlation between the food and the development of the reproductive organs.

CONCLUSION.

In the introduction to this study, mention was made of the necessity for a complete knowledge of both the environment and the life history of the organism before there could be a perfect understanding of the relations existing between the two. The data here presented are little more than an introduction to the facts that might be determined. So far as they are known, they point toward an independent relation between the Redwing and the marsh. In general, an organism is dependent upon its environment for food and shelter, for itself and offspring. The Redwing's independence of the food supply of the marsh has been discussed. During the greater part of the year it obtains its food outside of the marsh, and that which it does secure here, is taken, without selection, from the preponderant forms as they occur in succession. Its dependence upon the marsh, or, in other words, the reason for its being a marsh bird, lies in the shelter which it or its offspring receive. Generalized in structure as it is, and therefore adaptable, the Redwing was able to take to the marshes when crowded from its natural environment, and finding there little competition, easily established itself. In its previous habits it was perhaps similar to the Bobolink of to-day, and nested on open uplands. It may have come to the marshes naturally, through first seeking protection there during the migration, as do both the Bobolink and the Redwing at the present day. That this may have happened in comparatively recent times, is suggested by a number of considerations. In the first place, the Redwing shows no specialization to a marsh environment in either structure, food, or coloration. Secondly, it spends hardly more time in the marsh than is necessary to rear its young. Thirdly, it easily reverts to a dry-land nesting site when driven from the marshes by any catastrophe. Fourthly, it is still unable to cope with an emergency that must have always arisen in connection with its marsh nesting site, namely, the overturning of its nest by the growth of the vegetation. Fifthly, unlike the true marsh birds, it relies for safety primarily upon flight and not upon the shelter of the marsh itself.

The Redwing is a member of a large and widely distributed family of birds, which are very diverse in habits, occupy almost every type of environment, and yet retain great similarity of structure. The modifications occurring among the members of the family are for the most part slight. The birds in this group seem eminently generalized, adaptable to almost every environment and to almost every food. The Redwing is as generalized as any member. Its bill, for example, is heavy at the base and suitable for crushing seeds, and yet it is almost as finely pointed and sharply edged as a Warbler's; it is shorter and heavier, relatively, than the Grackle's, Oriole's, or Meadowlark's, but not so extreme in this respect as is the Bobolink's. The Redwing is to-day the dominant species of bird found in the marsh, and it has gained this ascendancy, not by permanent modification or specialization, but by a generalization of structure and an adaptability which permit it to utilize the richest resources of diverse environments. It is thus freed from the dependence which restricts the more specialized types of birds. Add to this the inconstancy of the conditions in the marsh, which tends to limit the abundance of the less adaptable species, and the dominance of the Redwing is easily understood. The Redwing is dominant because it is superior to its environment.

PLATE XXII.

The Red-winged Blackbird—not specialized, but eminently adapted to its environment.

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